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An Examination of the Impacts of Urbanization on Green Space Access and Water Resources: A Developed and Developing World Perspective

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An Examination of the Impacts of Urbanization on Green Space Access and Water Resources: A Developed and Developing World Perspective

by

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Dedication

I would like to dedicate this dissertation to my family. I am thankful to my parents who provided me with unconditional support over the years – their hard work and dedication enabled me to pursue my goals and I will forever be grateful. I am also appreciative to Carol and Roger for their encouragement and sincere interest in my work. Lastly, I want to thank Caleb for his unwavering support and patience.

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Abstract

This dissertation addresses the impact of urbanization and land use change on the availability and accessibility of two urban amenities that are often inequitably distributed: green space and water features. Diverse methodologies were utilized in order to gain a better understanding of the role of these amenities in improving urban quality of life and integrated water management. Using an interdisciplinary approach, this research provides a unique perspective within both a developed and developing world context by evaluating aspects of urbanization to emphasize more sustainable and integrated approaches to development.

A preliminary analysis highlights potential drivers of green space revitalization in Santa Cruz, Bolivia by identifying perceived benefits of brownfields redevelopment projects between developed and developing countries. These include environmental benefits (creation of green space, reduced health risks), economic benefits (job creation, retention of residents and businesses), and social benefits (community enhancement, improved city services). Building on this analysis, an in-depth anthropological study then examines the preferences, perceptions, and barriers to accessing green spaces in Santa Cruz. Utilizing qualitative and quantifiable research methods, it was determined that although green spaces can help ensure greater equality in urban areas by providing access to public spaces, significant gender discrepancies were noted in Santa Cruz.

Disparities in the distribution and accessibility of green space and water features were further assessed in Tampa, Florida. Using a Geographic Information System (GIS) and census data, access to these urban amenities was examined. The inner-city community of East Tampa was found to have greater inequalities, relative to other areas in Tampa, in terms of the quality, diversity, and size of green spaces within their community. The revitalization of urban water infrastructures, such as stormwater ponds, was evaluated as a way to address these environmental justice issues.

Lastly, impacts of urbanization, land use change, and population growth on water resources were analyzed using a regional water balance model for the city of Santa Cruz. Development scenarios were examined based on historical and future spatial and temporal changes. Between 1970 and 2010, a decreasing trend was observed for the aridity index (potential evapotranspiration over precipitation) while future climate projections (2011-2050) indicate a trend reversal, with the IPCC's emission scenario A1B having the strongest increasing trend. The increasing trend in the aridity index suggests a long-term shift in the regional hydroclimatology towards less humid conditions.

Each chapter of this research builds on the idea of green space as an indicator of urban quality of life (particularly for urban poor who rely more heavily on public spaces for leisure and recreation activities) as well as an important facilitator of urban hydrology due to their predominately permeable surfaces (including water features). Yet rapid change occurring in cities around the world has resulted in the under-valuation of both green space and water resources and thus these amenities have been degraded or destroyed through the urbanization process.

Chapter 1: Introduction

Urbanization is a global phenomenon that is quickly altering the physical structure of the planet. In many locations the division between urban and rural is blurring as development occurs further away from city centers. The form of future development has major implications for global sustainability including quality of life, environmental resiliency, and economic stability.

1.1 Global Changes

Rapidly occurring changes have resulted in an increasingly complex, or dynamic, world with exponential demands being placed on natural and built systems. Some of these global stressors include increases in population, urbanization, resource utilization, water consumption, vehicle ownership, land conversion, species extinction, and disease transmission (Grimm et al., 2008; Pimentel et al., 2007; Zimmerman et al., 2008). Figure 1 shows a causal loop diagram that depicts the connections between global stressors, environmental impacts, and social outcomes that are examined within this dissertation. This figure illustrates feedback processes encountered in many cities around the world due to poorly planned development and disparities in the provision of basic services, with a focus on availability and accessibility of green space as well as water resource impacts. Dynamic structures are identified in four main loops, with each loop outlining factors that contribute to urban conditions. The three balanced loops represent expansion of traditional green space, reduction in open space, and expansion of basic services. The only reinforcing loop – indicating perpetual growth or decline – represents exposure to green environments.

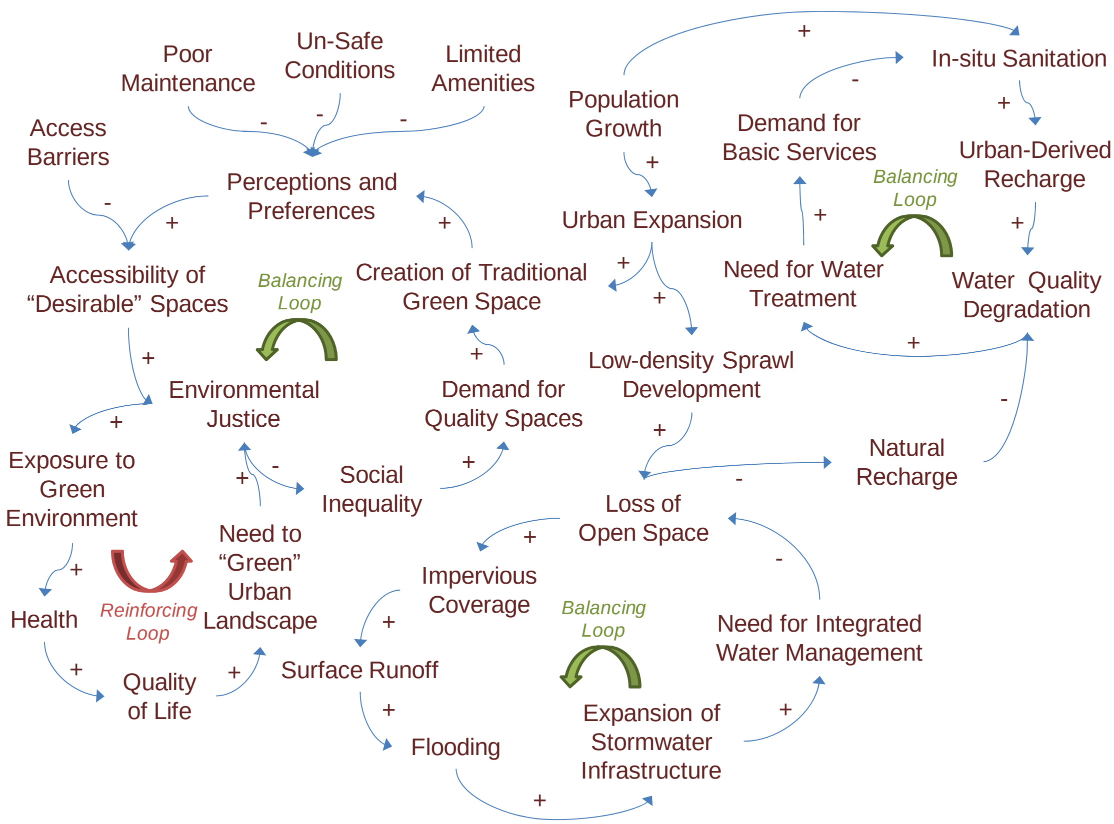

Figure 1. Causal loop diagram highlighting the connections between global stressors, environmental impacts, and social outcomes.

Globally there has been a migration to urban centers because they provide greater economic opportunities. As shown in Figure 2, by 2008 more than half of the global population was living in cities, and by 2050, that number will be greater than 70% (UNFPA, 2007). Cities are typically the primary location of economic growth and have more potential to reduce poverty than rural areas. Furthermore, countries that are more urbanized often have higher incomes, more stable economies, stronger institutions and are more capable of weathering fluctuations in the global economy (UNFPA, 2007). Despite these economic promises, very few cities in developing countries are able to create enough jobs to meet the demands of their increasing populations. Additionally, inequalities are often present in the distribution of the benefits of urbanization, particularly those related to health. Globally these disparities have continued to widen with population growth, however, in less developed nations, this has caused poverty to increase more rapidly in urban areas than in rural areas (UNFPA, 2007). As a result, over 90% of slum dwellers reside in the developing world.

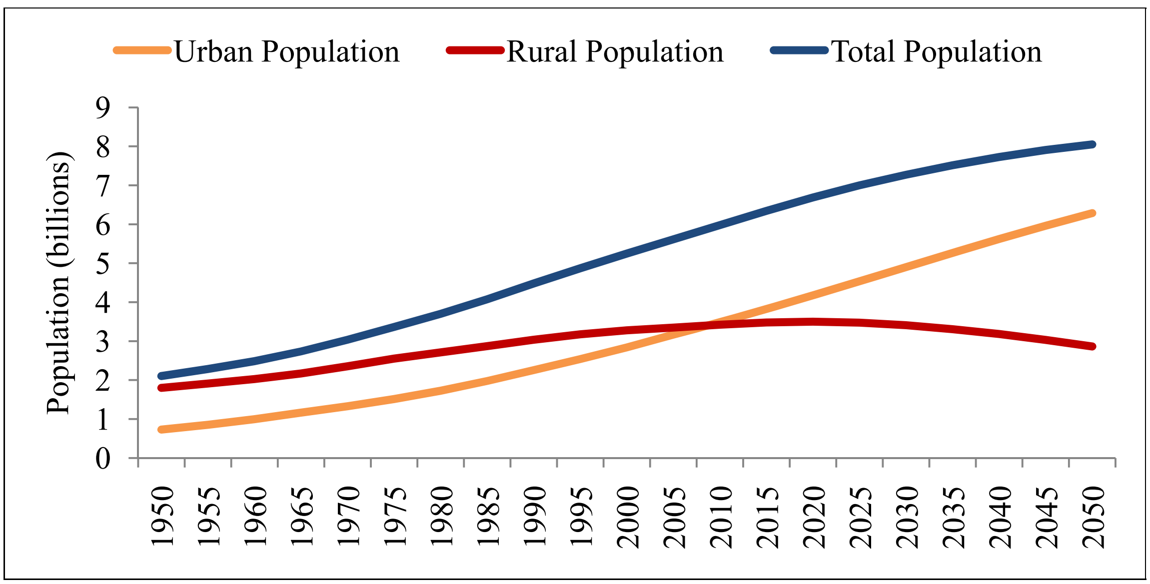

Figure 2. Global population, including the portion of rural and urban populations, from 1950 to predicted levels in 2050.

High levels of inequality have been found to produce negative social, economic and political impacts that can ultimately destabilize societies due to increased social unrest (UN-HABITAT, 2008). Also, the benefits of economic growth are diminished in societies containing both high levels of inequality and poverty. This highlights two key areas of development that must be addressed as cities become more densely urbanized with increasingly affluent populations – sustainability and equity.

The ways in which cities grow and develop has major implications for long-term sustainability. Improvements in transportation, specifically private transportation, have resulted in cities using more land per person as distance becomes less important. This has lead to a global transition from urban centrality to low-density sprawl development. It is estimated that between 2000 and 2030, the world's population will increase by 72%, but urbanized area will increase by 175% in cities with populations greater than 100,000 (UNFPA, 2007). Thus by 2030, the amount of urbanized land is expected to triple in developing world cities with populations greater than 100,000. Overall, the average urban density has decreased continuously over time, with the last decade experiencing a 1.7% and 2.2% annual decrease in density within the developing and developed world, respectively (UNFPA, 2007).

Therefore, development patterns have not only become less sustainable, but inequalities have become manifested in urban policies, which often neglect the needs of the urban poor (UNFPA, 2007). Although the social processes that have led to this land-intensive urbanization may differ between the developed and developing world, many of the outcomes are similar and include increased automobile travel and energy consumption, increased air and water pollution, loss of open space, reduced physical activity, loss of biodiversity, reduced "social capital", and greater socio-economic inequalities (Frumkin, 2002).

Globally, rapid urbanization is causing city planners to grapple with issues of sustainability, climate change, water scarcity, and dwindling natural resources, while also struggling to provide basic services to steadily growing urban populations (UN-HABITAT, 2001). Poorly planned developments, and their resulting problems with traffic, pollution, and reduced citizen quality of life, can often become a significant drain on economies – particularly when this results in the loss of productivity due to illness or loss of life from preventative diseases (Araby, 2002). Furthermore, there is often a lack of awareness in the linkages between environmental degradation, human health impacts, and poverty (Knuth, 2006). Although urban centers offer the possibility of sustainable development and improved quality of life, current urbanization patterns must be revised in order to break the negative feedback loop initiated in this land-intensive urban expansion. While at the consumer level, the trend of increasing per capita resource consumption and waste generation due to increasing affluence needs to be addressed in order to accommodate the needs of the current generation, as well as future generations.

The next two sub-sections examine the primary forms of sprawl development, which are discussed in the context of Latin America (peri-urban expansion) and the United States (suburban sprawl). The combination of different development pressures results in these two different forms of urban sprawl (UNFPA, 2007); therefore, these are briefly discussed within each context.

1.1.1 Urbanization in Latin America – Peri-Urban Expansion

Developing world cities add an average of five million residents each month and will account for almost 95% of the future population growth (UN-HABITAT, 2008). Latin America and the Caribbean is the most urbanized region in the developing world, with rapid growth of smaller cities, which contain almost 40% of the urban population, accounting for the bulk of future growth (UN-HABITAT, 2008). Furthermore, migration among cities, rather than from rural to urban areas, accounts for the urban growth in this region.

Due to the rapid urban transition, there have been many anti-urban policies in Latin America that have attempted to stem the flow of migrants into urban areas (UNFPA, 2007). Instead of focusing on policies that would have lead to a decline in fertility rates (i.e., social development, health and education investments, and reproductive health services for women), and therefore declines in growth rates, many instead focused on policies such as preventing the provision of basic services to new squatter or illegal settlements. Therefore, these anti-urban policies often made it more difficult for the urban poor to get out of poverty while also inhibiting the ability of municipalities to plan for urban growth.

Land speculation has also helped spur sprawl and low-density development in peripheral areas of urban centers in developing nations. This peri-urban growth differs from suburban sprawl in industrialized nations due to the nature of growth. Developments in these peri-urban areas are often beyond or between municipal limits, with governments having very little authority to regulate development or provide services (UNFPA, 2007). As a result, residents beyond the urban fringe experience more inequalities due to a lack of services and infrastructure, as well as land use changes that often contribute to greater levels of poverty, pollution, and degradation of natural resources. The adoption of the automobile as the dominant transportation mode in many developing nations has placed further stress on limited resources, governance systems, and infrastructures, while perpetuating sprawl development patterns (Freund et al., 2000).

1.1.2 Suburban Sprawl in the United States

In the United States, about half of the population lives in large metropolitan areas, with only 20% living in smaller urban areas or in rural counties (Pan American Health Organization, 2007). Although early cities were developed in a compact form that facilitated non-motorized forms of transportation with high levels of connectivity between residential and commercial areas, the introduction of private transportation quickly transformed modern cities. The automobile, which represents freedom and economic development to many, has in fact become the only means of mobility in many locations in the US (Freund & Martin, 2000). Although early highway projects were perceived by some as a means to revive declining urban cores after the second world war, the reality of these concrete jungles never matched the original futuristic and artistic designs (Mohl, 2004). Rather, many densely populated residential neighborhoods and intact communities were destroyed to make space for freeways. The automobile (and its associated infrastructure) has transformed the physical structure of communities and consumed large quantities of public space (Freund & Martin, 2000).

The development of the highway system, which began with the passage of the Federal-Aid Highway Act in 1956, encouraged sprawl and ex-urban growth via low-density development along major thoroughfares and tributaries. This pattern of development is characterized by highly connected residential and commercial growth with the provision of basic services and infrastructures. This form of development has high societal costs because it not only reduces funding for the maintenance of existing infrastructure (due to the need to continuously construct new infrastructure to ever-expanding suburban areas), but it also increases costs for this larger transportation network (McElfish, 2007). Sprawl has drawn residents and jobs into outlying suburban areas and unlike in developing nations, basic services are often subsidized for suburban development. This has resulted in less funding for public facilities and amenities, consumption of more resources, and the separation of inner-city and lower income residents from economic opportunities. Lastly, sprawl has eroded social connections and thus communities due to increased physical distances from other communities and amenities such as parks, schools, and stores.

1.2 Urban Amenities – Green Space and Water Resources

As previously mentioned, rapid urbanization is causing city planners to struggle with providing basic services and equitable access to urban amenities, including natural features such as green space and water resources. In fact, the loss of green space and degradation of water resources are but a few of the problems resulting from this fragmented, land-intensive development pattern. Protecting or preserving these natural amenities in sprawled urban areas is particularly important due to the negative correlation between this type of development and health (Liu et al., 2007). In fact, these natural environments have been described as "restorative environments" because of their ability to help promote mental health, as well as enhance self-esteem and mood (Barton et al., 2010).

Green spaces can be publicly or privately owned outdoor spaces that contain permeable surfaces and water features. Although it is important to evaluate these spaces within a cultural and geographic context, this broad definition provides a basis for classifying green space as parks, recreational areas, open spaces, wetlands, stormwater ponds, cemeteries, and gardens. Unconventional green spaces and/or urban water infrastructures (i.e., cemeteries and stormwater ponds) were examined in this research because they represent existing features within the urban landscape that help facilitate hydrological processes and offer the potential to increase access to existing public green spaces. Due to disparities in the provision of basic services, infrastructure, and natural amenities, these unconventional green spaces are especially important for the urban poor in both industrialized and developing nations.

Numerous studies have been conducted that illustrate the importance of green space on human health, communities, and the environment (Boone et al., 2009; Chiesura, 2004; Crompton, 2001; Maller et al., 2006). These studies have identified many benefits of green space, which have been summarized and grouped according to the three pillars of sustainability: social, environmental, and economic benefits (Table 1).

Table 1. Social, environmental, and economic benefits of green space.

Social Benefits	**Environmental Benefits**	**Economic Benefits**
Enhanced recreational opportunities Increased levels of physical activity Increased sense of security Improved mental health Reduced crime and juvenile delinquency	Improved air quality Water pollutant filtration Increased control of stormwater runoff & flooding Reduced loads on stormwater systems Groundwater recharge Reduced heat island effect Wildlife habitat	Increased property values Improved ability to attract and retain businesses and residents Tourism Decreased needs for police and prisons Reduced pollution prevention measures

Despite the fact that the majority of the world's urban population is found in developing countries, previous studies have primarily focused on industrialized nations such as the United States, Europe, and Australia. As shown in Table 2, very little work has been conducted in the rapidly urbanizing cities in the developing world. Furthermore, an evaluation of key words from each study illustrates a gap in current research. Although many studies have evaluated issues related to the availability and accessibility of green spaces and natural environments (as well as other urban amenities), very few have examined the integration of natural and built systems to improve access equality and availability. Additionally, although a few address the hydrological benefits of green space, none evaluate the inclusion of urban water infrastructure into green spaces as a way to promote sustainable development and enhanced quality of life.

Table 2. Geographic location (italics indicate if the site considered a developing nation) and key words of studies examining topics related to green space.

Reference	**Geographic Location**	**Key Words**
Bolund et al. (1999)	Sweden	Ecosystem, ecosystem services, urban areas
Crompton (2001)	USA	Parks, open space, property values
Lindsey et al. (2001)	USA	Access, equity planning, greenways
Araby (2002)	*Egypt*	Sustainability, environmental degradation, mega-city
Gobster (2001)	USA	Ethnicity, urban parks, participation, preferences, social groups, discrimination
De Vries et al. (2003)	The Netherlands	Natural environments, green space, health
Chiesura (2004)	The Netherlands	Urban parks, quality of life, city sustainability
Giles-Corti et al. (2005)	Australia	Public open space, physical activity, accessibility, walking
Southworth (2005)	USA	Urban planning, pedestrians, design, bicycles, walkways
Maas et al. (2006)	The Netherlands	Green space, urbanity, health
Maller et al. (2006)	N/A (empirical summary)	Nature, health promotion, mental health, ecological health
Pauchard et al. (2006)	*Chile*	Homogenization, urban ecology, South America, Chile
Sherer (2006)	USA	City parks, open space, benefits
Kipke et al. (2007)	USA	Children, obesity, fast-food restaurants, ethnography, spatial analysis
Liu et al. (2007)	USA	Obesity, environmental design, ecosystem, food industry, prevention research
Sister et al. (2007)	USA	Park congestion, park equity, Thiessen polygons, service areas
Mitchell et al. (2008)	England	Exposure, natural environment, green space, health inequalities
Pilgrim et al. (2008)	UK, *India*, *Indonesia*	Ecological knowledge, income levels, knowledge transfer, economic growth
Boone et al. (2009)	USA	Environmental justice, parks, segregation
Budruk et al. (2009)	*India*	New ecological paradigm, place dependence, place identity, urban green spaces
James et al. (2009)	Europe	Delphi technique, urban ecology
Barton et al. (2010)	UK	Dose, green exercise, mental health

1.3 Research Objectives

The main theme of this research is to analyze urbanization and its impact on green space and water resources, in terms of availability, accessibility, and usability. This research aims to highlight the importance of green space in the urban landscape through an interdisciplinary framework that provides linkages between the numerous social, environmental, and economic benefits of enhancing the quality and quantity of urban green spaces. This research incorporates local perceptions of green space and water features (including urban water infrastructures), which allows these issues to be examined within a culturally- and geographically- appropriate context. A more sustainable and holistic form of development is advocated throughout this research to not only ensure a higher quality of life for urban residents, but also to improve the resiliency of natural and built infrastructures against increasing global stressors.

The complexity of urban systems, which integrate the built environment, the natural environment, and human systems, requires a systems thinking approach and resulted in the following four research objectives:

1. Identify the social, environmental, and economic drivers of green space revitalization in a developing world context;
2. Determine the preferences, perceptions, and barriers to accessing green spaces in a rapidly urbanizing city in the developing world;
3. Examine disparities in green space access and evaluate the role of urban water infrastructure in improving access in an inner-city community in an industrialized nation; and
4. Analyze the impacts of the following stressors on urban hydrology in a developing world city at a regional scale: urbanization, population growth, and reduced green space coverage.

1.4 Dissertation Overview

This research focuses on two sites, one in the developing world (Santa Cruz, Bolivia), and the other in the developed world (Tampa, Florida). The city of Santa Cruz provides a look into rapid urbanization in a developing world context. The exponential population growth of Santa Cruz and poorly planned peri-urbanization have created numerous social, environmental, and economic problems that are also characteristic of many other developing world cities. In contrast to Santa Cruz, within Tampa, the inner-city community of Tampa provides a different view of urbanization. East Tampa represents a community that already experienced its peak urbanization and has been in decline for the past several decades. Although this community has initiated revitalization efforts, it continues to deal with land vacancies, deteriorating structures, crime, and unemployment, which are also found in many former industrial cities within the developed world. Furthermore, within both Santa Cruz and East Tampa there are numerous brownfields as well as built or natural water drainage features (*curichis* in Santa Cruz and stormwater ponds in East Tampa, both of which are negatively perceived in each location).

The result of this research has been one publication in print, two in review, and one in preparation. These publications make up the body of the dissertation, which consists of four chapters that relate directly to the previous research objectives and build on the perception, availability, and accessibility of green space and water resource within different urbanization contexts:

Chapter 2 will introduce readers to the issue of illegal waste management, and hence brownfields development, as a product of urbanization in the peri-urban areas of

Santa Cruz, Bolivia. A case study of a *curichi* (degraded wetland) is explored to highlight the connection between various types of risks and the desired social and economic values and ecological functions of a properly functioning wetland system. This chapter was presented at the 7th International Conference on Ecosystems and Sustainable Development (and published in the conference proceedings) (Wright Wendel et al., 2009).

Chapter 3 broadens the view of green space to include formal and informal, as well as both natural and human-modified spaces, in Santa Cruz. In this chapter, green spaces are analyzed as an indicator of urban quality of life using an anthropological approach to better understand the issue of green space perception and preference in a developing world context. Qualitative and quantified methods are employed to evaluate issues of green space access, including the identification of any access barriers, at the city level. Preliminary results were presented at the Society of Applied Anthropology 2010 Annual Meeting (Wright Wendel et al., 2010), the 5th International Conference on Social Science Research (Pfister et al., 2010), the Universidad Tecnológica Boliviana (La Paz), and this chapter has been submitted to *Society and Natural Resources* (Wright Wendel et al., 2011c).

Chapter 4 shifts to Tampa (Florida) to continue evaluating the issue of green space accessibility, however, the definition of green spaces is further expanded to in incorporate water features (both natural and engineered infrastructure). Using a Geographic Information System (GIS) and census data, the spatial distribution of green space along with socio-demographic data are evaluated to assess whether access to green space is equitable between Tampa and the inner-city community of East Tampa. The issue of environmental justice and urban water management is explored to evaluate potential improvements in green space and water access through the revitalization of existing engineered water infrastructures. This chapter has been submitted to *Environmental Science and Technology* (Wright Wendel et al., 2011b). Further work that compares the results from East Tampa with a new community (South Tampa) (see Appendix C: Improving Urban Quality of Life by Enhancing Access to Unconventional Green Spaces and Water Infrastructure) will be presented at the International Water Association Cities of the Future 2011 conference (and was submitted as a publication for the conference proceedings) (Wright Wendel et al., 2011a).

Chapter 5 builds on the insights gained from the first four chapters in regards to local perceptions and use of green space, as well as the importance of more equitable distribution of green space and water resources. This chapter moves back to Santa Cruz and presents the results of a regional water balance model that is used to examine the impacts of changes to three main stressors over time – urbanization, population growth, and reduced green space coverage. Future hydrological impacts are assessed, namely changes in groundwater recharge, as a function of spatial alterations (i.e., land use changes) and temporal changes (i.e., climate change). A condensed version of chapter 5 will be presented as a poster at the 2011 Association of Environmental Engineering and Science Professors Education and Research Conference with a planned submission of a peer reviewed journal.

Finally, chapter 6 contains conclusions and recommendations from the research conducted in the preceding chapters.

Chapter 2: Evaluating the Social, Economic, and Environmental Drivers of Urban Brownfields Redevelopment in Santa Cruz, Bolivia[1]

2.1 Introduction

The term "brownfields" is often used in developed countries to indicate former industrial and commercial sites that are either contaminated, unused, and/or abandoned (US Environmental Protection Agency, 2008). Alker *et al* (Alker et al., 2000) defines a brownfield site as "any land or premises which has previously been used or developed and is not currently fully in use, although it may be partially occupied or utilized. It may also be vacant, derelict or contaminated. Therefore a brownfield site is not available for immediate use without intervention." Based on this definition, brownfields can be located within both developed and developing countries.

At the international level, several frameworks and programs exist that address development issues, such as ecological conservation and environmental risks. The United Nations' Agenda 21 and Millennium Development Goals are two examples that have international implications for brownfields redevelopment (UN Department of Economic and Social Affairs, 2004; United Nations Development Programme, 2008). As an example, the following areas were highlighted as goals for shaping the Bolivian National Solid Waste Management Strategy, to avoid the creation of additional brownfield sites (Ministerio de Servicios y Obras Publicas, 2005):

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[1] Courtesy of WIT Press from WIT Transactions on Ecology and the Environment, Volume 122, 2009, pages 343-352.

- *Chapter 21 of Agenda 21:* a) Reduce waste production; b) Increase environmentally favorable waste reuse and recycling; c) Promote environmentally favorable waste disposal and treatment; and d) Expand waste service coverage.
- *Goal 7 of the Millennium Development Goals:* a) Integrate sustainable development principles into policies and programs to reverse losses of natural resources; b) Reduce biodiversity loss; c) Reduce, by half, the percentage of people lacking sustainable access to safe drinking water and basic sanitation by 2015; and d) Significantly improve, by 2020, the lives of at least 100 million slum dwellers.

2.1.1 Estimated Extent of Brownfields in the United States

Brownfield sites are often associated with negative perceptions, yet these sites often represent under-utilized potential within urban areas (DePass, 2006). Some of these perceptions include visual blight, lower municipal revenues, environmental and health risks, safety hazards, crime, and illegal dumping (DeSousa, 2006). Unfortunately, many communities do not even have formal inventories of their brownfield sites. This is often the case in communities with less intensive industrial pasts (i.e., less potential for brownfields), or due to fear that property values may be reduced if brownfield sites are publicly documented within the community (DeSousa, 2006). In developed countries, even though brownfields may occupy only a small percentage of urban land, these sites can represent a significant problem because of their concentrated locations. For example, in the U.S., 2-3 percent of the total land area is built on (primarily urban) (Mihelcic et al., 2009); however, the estimated 450,000 brownfield sites may occupy 6-15 percent of that urban land (DeSousa, 2006; Pagano et al., 2000; US Environmental Protection Agency, 2008).

2.1.2 Extent of Brownfields Largely Unknown in Bolivia

Although the term "brownfield" is often used in developed countries to describe vacant or contaminated industrial or commercial sites, it can also be applied to areas in developing countries that have been contaminated by a variety of domestic or industrial uses (e.g., legal and illegal waste disposal, untreated wastewater, commercial processes). In developing countries, brownfield sites are not only unaccounted for, but they are often still being created as communities struggle to develop and deal with increasing quantities of less organic wastes.

Due to the changing composition in the waste streams of many developing countries – from primarily organic to more commonly non-biodegradable – many brownfield sites are created due to improper solid waste disposal (Gobierno Municipal de Santa Cruz de la Sierra, 2004; Ministerio de Servicios y Obras Publicas, 2005). In the city of Santa Cruz, Bolivia, at least 53 sites (0.25-5 hectares, 1-4 meters deep) exist that are abandoned brick-making enterprises (*ex-tejerias*); 12 of which have been converted into illegal dumps (*curichis*) (Gobierno Municipal de Santa Cruz de la Sierra, 2004). Some of these ex-tejerias are left to natural succession; however, the majority are either used to illegally dispose of all types of wastes or are legally filled in with construction debris and other rubble to create areas for housing.

2.1.3 Objectives

The health benefits derived from exposure to green spaces, such as enhanced physical activity and reduced blood pressure and stress levels, have been documented by previous studies (DeSousa, 2003; Mitchell et al., 2008). Mitchell *et al* [12] found that populations exposed to areas with more green space had lower levels of income-related health inequalities; while those populations lacking green space exposure were less protected from health inequalities related to income deprivation.

Therefore, in terms of reducing health and other social inequalities, it appears to be beneficial for communities going through rapid urbanization to either protect their natural environments, or to restore green spaces via brownfields redevelopment (Mitchell & Popham, 2008). This paper will examine a variety of driving factors behind brownfield redevelopment projects in the developing and developed world. Specifically this paper will:

- Assess the environmental, social, and economic benefits that impact brownfields redevelopment projects; and
- Determine the connections between environmental, social, and economic risks and the desired societal values and ecological functions of a case study brownfield site located in the developing world.

2.2 Case Study: Brownfields in Santa Cruz, Bolivia

2.2.1 Socio-Economic Condition of Bolivia

According to the World Resources Institute (World Resources Institute, 2005), 1.3 million Bolivians live on less than one dollar per day, with 5.1 million living below the basic needs poverty line. In 2001, 61 percent of the Bolivian urban population was living in slum conditions, whereas the average in South America was only 36 percent. Additionally, Bolivia has a large gap in economic equality – the wealthiest 20 percent of the population account for almost half of the total spending, yet the poorest 20 percent account for only four percent. As illustrated in Table 3, despite the socio-economic problems of Bolivia, it is rich in natural capital. More than 11 percent of the total land area is protected in Bolivia, which is well above the 5.9 percent average for South America.

Table 3. Socio-economic indicators for the United States and Bolivia (World Resources Institute, 2005).

Indicators	**United States**	**Bolivia**
Population (2006)	300,038,000	9,138,000
Population annual growth rate	1.10	2.74
Life expectancy (years)	77.3	63.9
Number living on >$1/day	-	14.4%
National Poverty Rate	-	62.7%
Human Development Index (1=most developed)	0.94	0.68
GDP per capita (2002)	$35,746	$2,459
Health care expenditures per capita, total (2001)	$4,887	$125
Male Annual income	$43,797	$3,463
Female Annual income	$27,338	$1,559
Total land protected	8.4%	11.1%
Number of wetlands of international importance	21	8
Number of biosphere reserves	47	3

2.2.2 Brownfields Formation in Santa Cruz, Bolivia

In the last several decades, the population of Santa Cruz has grown rapidly to over 2 million inhabitants, making it the largest city in Bolivia. While the national growth rate for Bolivia was 2.7 percent between 1992-2001 (3.6 percent in urban areas and 1.4 percent in rural areas), the department of Santa Cruz grew at a rate of 4.3 percent (4.9

percent in urban areas and 2.6 percent in rural areas) during the same time period (Instituto Nacional de Estadística, 2008). With this population growth, throughout the city of Santa Cruz, green space has been lost due to urban development. However, much of the remaining green space has been degraded by improper municipal waste management practices (Gobierno Municipal de Santa Cruz de la Sierra, 2004). The loss of green space and poor waste management have resulted in: 1) increased groundwater pollution and urban stormwater drainage problems; 2) reduced air quality; and 3) loss of natural resources (Gobierno Municipal de Santa Cruz de la Sierra, 2004; Ministerio de Servicios y Obras Publicas, 2005; Museo de Historia Natural Noel Kempff Mercado, 2007).

Throughout Santa Cruz (Figure 3), many brownfield sites have been created as a result of unsustainable waste management. These sites are an indirect result of brick-making enterprises, which create depressions in the landscape as they extract clay soil. Once abandoned, these depressions develop into wetland-type habitats. However, rapidly expanding city limits have placed these sites within or near communities. Due to a lack of waste management and education, residents use these sites to illegally dispose of all types of wastes, including hazardous and biological wastes (Gobierno Municipal de Santa Cruz de la Sierra, 2004). After decades of degradation, these curichis have lost much of their natural water-storage capacity as well as biodiversity (Museo de Historia Natural Noel Kempff Mercado, 2007).

Much of the waste discarded in these curichis (e.g., tires, plastics, metals, electronics) is processed via open burning, which is detrimental to both human health and the environment. Residents have reported health problems they associate with open burning events; however, many of the low-income communities lack the resources and knowledge to effectively change these long-standing social practices or engage the assistance of the municipal government.

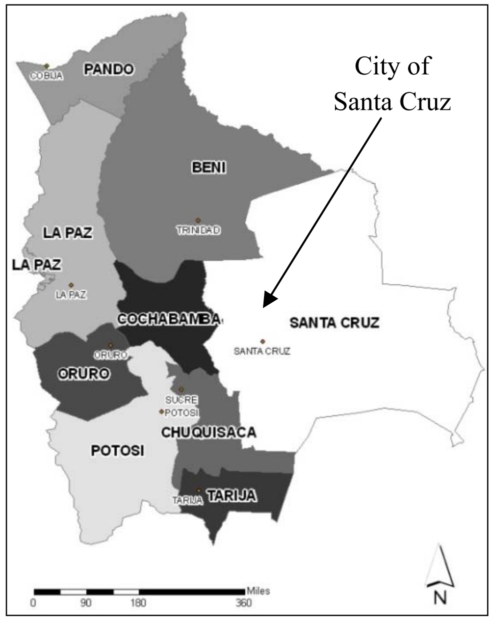

Figure 3. Map of land-locked Bolivia, including the department of Santa Cruz and the city of Santa Cruz.

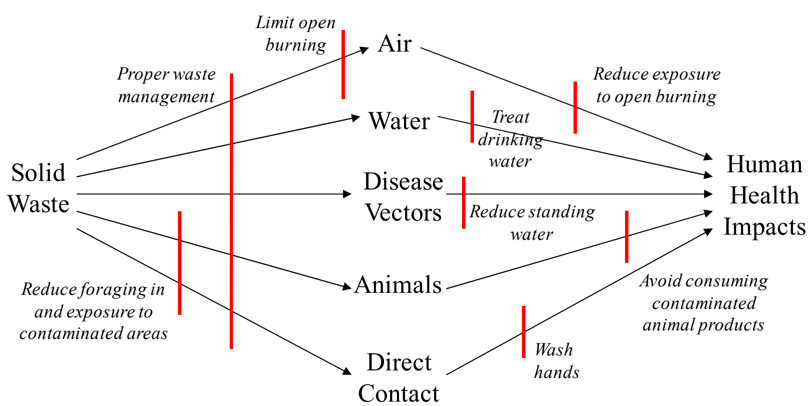

Figure 4. Modified “F-Diagram” developed for this study for solid waste that includes five routes of exposure: air, water, disease vectors, animals, and direct contact. Barriers to transmission, indicated by italics, include engineering and policy solutions and social behavior changes – all requiring a certain level of formal or informal education.

Air pollution, water contamination, direct contact, and disease transmission are several of the important exposure routes identified for improperly disposed municipal waste in Santa Cruz curichis (Figure 4). These exposure routes have the greatest socio-economic impacts for residents, particularly children (Gobierno Municipal de Santa Cruz de la Sierra, 2004).

2.3 Results

The benefits of brownfields redevelopment in developed countries are well documented (Deason et al., 2001; DeSousa, 2003, 2006; Dorsey, 2003; Paull, 2007); however, brownfields and other contaminated sites are just now starting to be considered in some developing countries (Bezama et al., 2008; Gobierno Municipal de Santa Cruz de la Sierra, 2004; Ministerio de Servicios y Obras Publicas, 2005). Therefore, it is important to identify the potential benefits of brownfields redevelopment in order to restore the desired values and functions of these sites. Benefits of brownfields redevelopment were identified for a developed country (U.S.) and a developing country (Bolivia) to examine differences and similarities that may exist. Key environmental, economic, and social benefits were selected based on available literature and the primary author’s experience with brownfield sites in Bolivia (Table 4).

Table 4. Potential benefits of brownfields redevelopment that are perceived in the U.S. and Bolivia – assuming mixed projects of residential/retail and various types of green space (Deason et al., 2001; DeSousa, 2003; Dorsey, 2003; Mitchell & Popham, 2008; Swanwick et al., 2003).

Type of Benefit	**Developed (U.S.)**	**Developing (Bolivia)**
	Environmental Benefits	
Reduce health risks	Reduce chronic health risks such as cancer, nervous system damage, heavy metal poisoning, etc;	Reduce acute health risks (i.e., malaria, diarrhea, respiratory ailments) and chronic risks
Creation of green space	Contribute to maintaining biodiversity, moderating the heat island effect, reducing pollution, and demonstrating sustainable urban environmental management	Provide sustainable stormwater drainage, pollution reduction, urban wildlife habitat, and community gathering sites (i.e., soccer field, parks)
Environmental justice	Increase access by lower-income residents to environmental recreational opportunities	Reduce exposure by lower-income residents to illegal dumps and associated health risks
	Economic Benefits	
Job creation	Increase local and regional jobs in retail, housing services, and/or park maintenance	Increase opportunities for individual family businesses or green space maintenance
Spill-over economic effects	Improve overall neighborhood quality, attract investment, increase property values, and stimulate local economies	Reduce crime, improve community health, and prevent flood damage
Prevent housing abandonment	Increase desirability to live in urban area and reduce urban sprawl pressures	Reduce crime and improve aesthetics
	Social Benefits	
Restore neighborhood empowerment	Improve residents' overall well-being and renew sense of pride in community	Improve overall residents' well-being and renew sense of hope in community
Use of existing infrastructure	Reduce pressure on undeveloped greenfields	Reduce development costs and protect green spaces
Improve city services	Increase tax revenues and revitalize urban landscape	Increase urban drainage and improve recreation areas

For both the U.S. and Bolivia, incorporating green space into brownfields redevelopment would help provide safe access to urban environmental services (i.e., recreation opportunities, urban wildlife habitat, pollution reduction, etc), which would restore economic and social values and enhance urban environmental functions. Additionally, both countries would benefit from reduced health risks (both chronic and acute for Bolivians), greater environmental justice – particularly for lower-income groups, and greater overall well-being for residents. The differences between the two countries were most apparent for the economic benefits of redevelopment. Communities in the U.S. would benefit from increased jobs, tax revenues, and property values, as well as reduced urban sprawl; whereas communities in Bolivia would benefit from reductions in flood damage, crime, and health risks (and their associated costs).

Figures 5 and 6 illustrate the connections between various types of risks and the desired social and economic values and ecological functions for curichi brownfield sites in Santa Cruz, Bolivia. Figure 5 focuses on engineering and policy solutions that would reduce existing human health risks as well as restore ecological functions and societal values to the curichis. Figure 6 demonstrates important social behavior changes that would reduce economic, human health, and environmental risks, achieve societal and economic benefits, and restore societal values and ecological functions to the curichis in Santa Cruz. In order to achieve the desired brownfield functions and values, both engineering/policy solutions and social behavior changes need to be jointly implemented. As shown with the Bolivian National Solid Waste Management Strategy [5], policies and practices are being discussed at the national level to improve solid waste management. Incorporating environmental education into the Bolivian school system has been put forth as a primary method for achieving these desired behavior changes in the long term (Ministerio de Servicios y Obras Publicas, 2005). Currently, few schools in Santa Cruz have any sort of environmental education program; however, this is beginning to change.

Several small-scale environmental education programs have been initiated despite funding issues, which has reduced the extent to which these programs can be implemented, particularly for public schools (Colque, 2008).

The larger issue with the redevelopment of brownfields in Santa Cruz, as with many other areas in the world, is creating an awareness of the inter-related problems of environmental degradation, human health impacts, and economic viability. Additionally, these long-term problems require collaborative partnerships between diverse stakeholders that includes learning and trust-building among all participants.

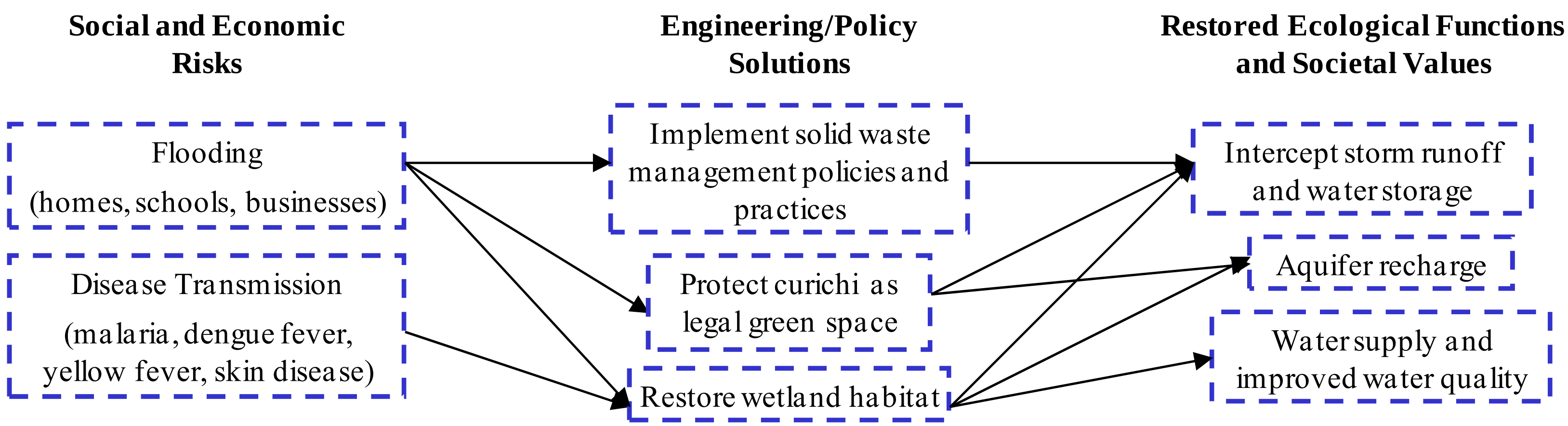

Figure 5. Proposed engineering and policy solutions to reduce existing human health risks and restore ecological functions and societal values to brownfield sites (*curichis*) in Santa Cruz, Bolivia.

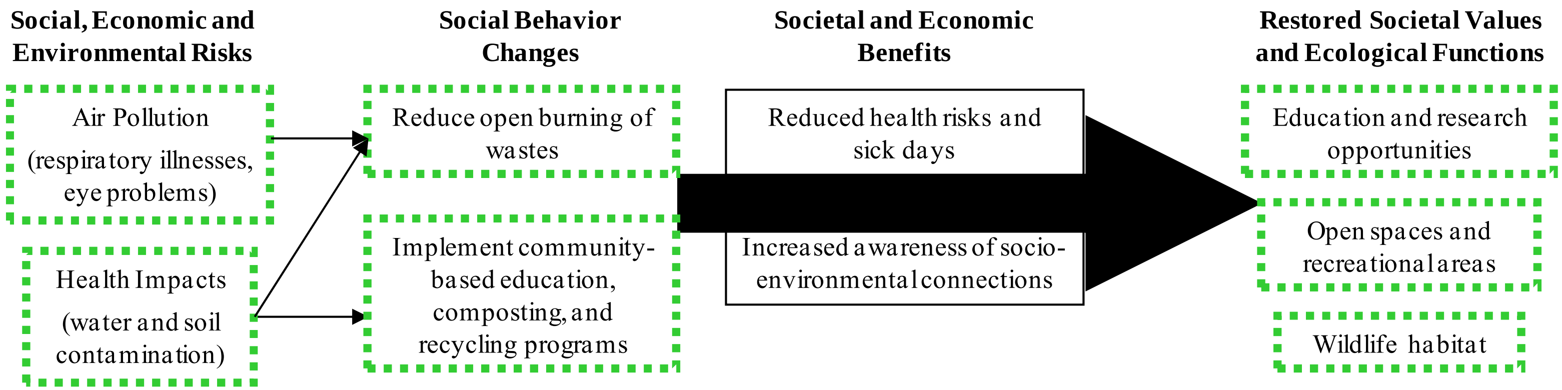

Figure 6. Necessary social behavior changes to reduce economic, human health, and environmental risks, to achieve societal and economic benefits, and to restore societal values and ecological functions to brownfield sites (*curichis*) in Santa Cruz, Bolivia.

Chapter 3: Preferences, Perceptions, and Barriers to Green Space Access in a Rapidly Urbanizing City (Santa Cruz, Bolivia)

3.1 Introduction

Currently more than half of the world's population live in urban areas (UNFPA, 2007). By 2030 that number will increase to 60 percent, with developing countries containing 80 percent of the urban population. While Latin America is currently the most urbanized region in the developing world it is also characterized by extremely high levels of urban inequality (UN-HABITAT, 2008). When resources and infrastructure are inequitably distributed, all facets of daily life for urban residents are negatively impacted, particularly those related to socio-economic development, gender, and health. For example, men and women experience urban living differently, often resulting in more barriers for women to access services and public spaces. Unfortunately, these inequalities are continuing to widen with increasing urban population growth and development patterns (UNFPA, 2007). Green space is one aspect of urbanization that is important to consider because it is an indicator of urban quality of life.

Urban sprawl is a global problem. It is partially comprised of unplanned and illegal development at the peri-urban interface in many developing world cities (UN-HABITAT, 2010). This development pattern has resulted in increased social and spatial inequality, resource consumption, and environmental degradation (Leichenko et al., 2008). Improving access to urban green space is one means for improving equality within urban areas (UNFPA, 2007). Yet cities undergoing rapid urbanization often destroy or degrade these spaces to make way for other land uses. As a result, the undervaluation, coinciding with the view of green space as a luxury, has produced less equitable distribution and access to green space within many urban areas. Furthermore, although the majority of the world's urban population is found in developing countries, there has been very little research regarding the use and perception of green space in such rapidly urbanizing cities. Rather, the majority of previous studies have focused on industrialized countries, specifically the United States, Europe, and Australia (Giles-Corti et al., 2005; Lindsey et al., 2001; Maas et al., 2006).

This research focuses on the rapidly urbanizing, sprawling city of Santa Cruz, located in Bolivia, which is characterized by high levels of inequality, particularly with regards to poverty and access to basic services (WRI, 2005). Beginning in 2006, the municipal government of Santa Cruz initiated a campaign to revitalize and expand green space (through the creation of large urban parks) within each district of the city to improve overall access (GMSC, 2007). Within the context of the municipal green space expansion, the objectives of this study are to: 1) Examine the types of green space that residents of Santa Cruz prefer and use; 2) Determine the benefits that residents perceive from different types of green space; 3) Assess how green space accessibility impacts use; and 4) Examine existing barriers that limit access to green space.

3.1.1 Urban Green Space

Green spaces, either publicly or privately owned, may be vegetated natural or human-modified outdoor spaces that can include parks, outdoor recreational spaces, open space, wetlands, and cemeteries (Budruk et al., 2009). Public green spaces are able to improve social inclusion because they are free and available for all (Dunnett et al., 2002). This is particularly important for lower-income urban residents who rely on these spaces for the majority of their leisure and recreational activities. Furthermore, high levels of inequality and a lack of public green space have both been linked to increased levels of crime (UN-HABITAT, 2008).

Numerous studies have illustrated the social, environmental, and economic importance of urban green space (Boone et al., 2009; Chiesura, 2004; Crompton, 2001; Wright Wendel et al., 2011b). In particular, many urban residents use green space as a way to escape the daily stresses and demands of city living (Maller et al., 2006). Furthermore, the perception of overall general health was found to be better for people living in a green environment (Southworth, 2005). Yet within industrialized countries, it has been documented that females, elderly, and less educated individuals have lower green space use and adults living below the poverty line were three times less likely to be physically active then higher-income adults (Lindsey et al., 2001; Sherer, 2006). Wong (1997) (cited in Maller et al. 2006) examined the benefits of exposure to nature for migrants, which included among other things, an increased sense of identity and ownership; a reunion with nature; the reawakening of a sense of possibility, relief from daily struggles; empowerment, and the enabling of environmental stewardship. This has important implications for cities around the world that are experiencing a large influx of migrants, such as Santa Cruz (GMSC, 2007).

While there are many benefits associated with urban green space, negative perceptions of these areas can also develop if they are congested, neglected, poorly maintained, or unsafe. Problems with litter or vandalism can cause potential park users to perceive these areas as being dangerous, unpleasant, or unwelcoming, all of which can lead to a decline in use or complete avoidance (Boone et al., 2009). Additionally, a decrease in use can result if green spaces are not able to accommodate the preferences of different user groups. Consequently, the following factors were found to influence the use of public green space: quality and quantity of spaces; user socio-demographic characteristics; access to competing facilities; ability for amenities to match user needs; maintenance; and perceived safety (Giles-Corti et al., 2005). In general, green space users were found to prefer nearby, attractive, and larger areas; however, after distance was taken into account, size was considered more important than attractiveness for encouraging use. This is a result of the perception that larger parks have more amenities.

3.1.2 Historical Development of Green Spaces

In Europe, the green space movement was initially influenced by royal parks near London, with the creation of large parks that simulated the rural landscape (H. W. Lawrence, 1993). This early design of European parks strongly influenced the green space movement in the United States (Taylor, 1995). The large urban parks were seen as an outlet from the dangerous conditions of the early industrial city (e.g., overcrowding, pollution, and stress) (Sherer, 2006). Although the design and amenities of these first parks in Europe reflected the tastes and interests of the elite class, they did provide a venue for working out class struggles and were also the first means of integrating nature into the urban landscape (H. W. Lawrence, 1993).

The early structure of many Latin American cities, including the placement and design of green spaces, was the result of colonial interventions (Mogollón, 2004). However, European modernist concepts did not account for the realities of urban life in Latin America and these idealized designs were quickly overwhelmed with uncontrolled development in green spaces that resulted in a loss of these urban amenities (Kirshner, 2009). Furthermore, efforts to protect natural ecosystems, particularly from international donors, have often focused on large areas located in less densely populated areas (Arambiza et al., 2006; Budruk et al., 2009). Consequently, urban green spaces have not been as widely adopted in present day Latin American cities (Nascimento et al., 1997). In the past decade however, in cities such as Bogotá, Columbia, Säo Paulo, Brazil, and Santa Cruz, Bolivia, access to urban public green space has been increased to improve urban quality of life (GMSC, 2007; UNFPA, 2007).

3.2 Methods

3.2.1 Study Site

Although Santa Cruz is now the largest city in Bolivia, in 1950 it was an isolated frontier outpost with a population of only 43,000 (Kirshner, 2009). Before 1950, migrants came primarily from the rural areas of the Santa Cruz Department, and only a quarter of the population was urban. By 1976 (and continuing through the 1990s), more migrants were coming from the western highland areas. Urbanization continued at a rapid pace so that by 1976, more than half of the department population was urban and by 2001, three-quarters were residing in urban areas. As of 2001 (most recent census data), migrants accounted for 38 percent of the city's population and the average annual growth rate between 1992 and 2001 was over five percent within the department (national growth rate was 2.7 percent during the same time period) (INE, 2002). In 2006, with a population of over 1.5 million, Santa Cruz was ranked as the fourteenth fastest growing city in the world among cities with populations greater than one million (GMSC, 2007).

In the 1960s and early 1970s, based on European modernist designs, Santa Cruz was constructed in four concentric rings (Figure 7), with greenbelts and *Unidades Vecinales* (*UVs*, or neighborhood units) situated along the ring roads surrounding the city center (Kirshner, 2009). The greenbelts were designed to preserve open land, parks, and farmland beyond the ring roads to provide amenities for recreational opportunities as well as to help control population expansion. However, almost immediately, population growth outpaced the original design, which resulted in a lack of adequate housing, employment, and basic services in the peri-urban area that still continues today (GMSC, 2007). This has exacerbated inequalities between the central and the outer districts, such as disparities in poverty levels (Figure 7) and socio-economic opportunities.

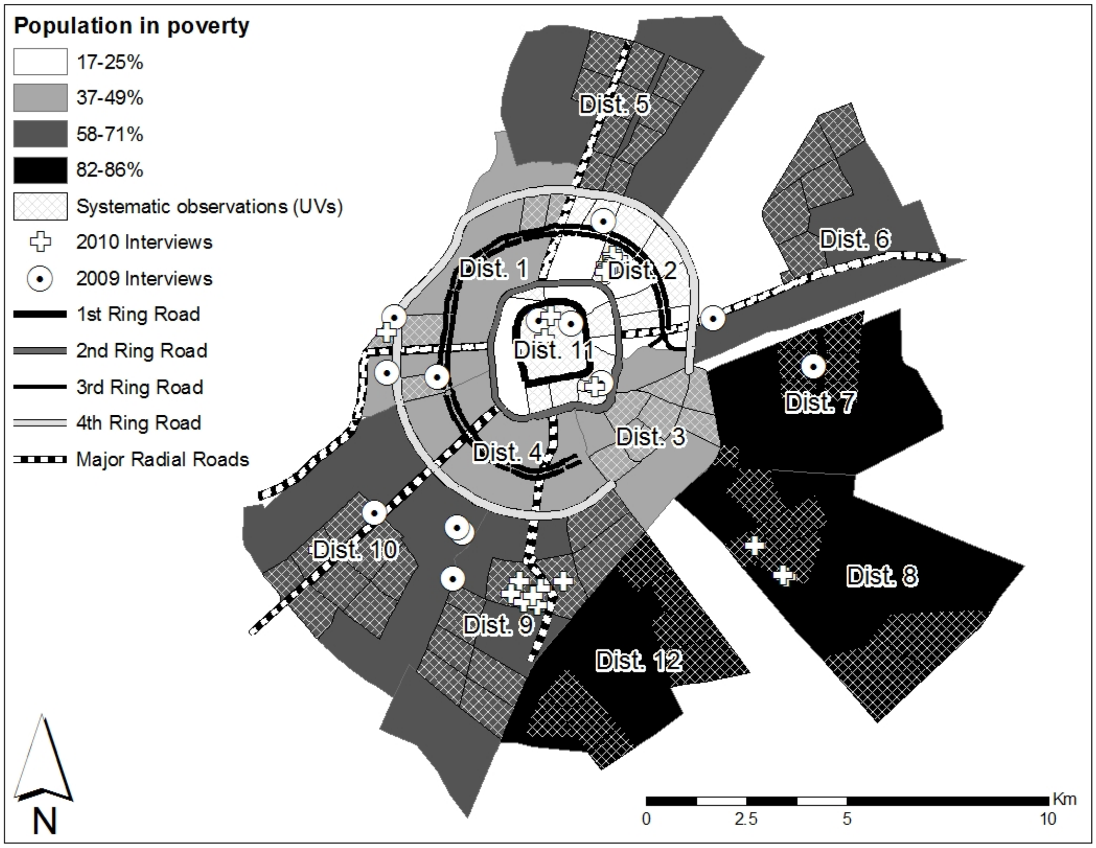

Figure 7. City of Santa Cruz, located within the department of Santa Cruz (Bolivia), illustrating the 12 districts, percent of population in poverty, four major ring roads, and locations of interviews and systematic green space observations.

Many *cruceños* (Santa Cruz's long-time residents) view the informal settlements in the peripheral areas and in green spaces by recent immigrants as an invasion (Kirshner, 2009). Therefore, immigrants have been stigmatized as being unwanted outsiders who are an economic burden that increase poverty, make it more difficult to provide services, and harm the city's image (GMSC, 2007). This has led to immigrants settling in many of the outer districts of the city that have higher concentrations of residents from the same place of origin. Although one quarter of recent migrants have come from within the Santa Cruz Department, more than half have come from the western highlands. Looking at settlements in specific districts (defined in Figure 7), 20 percent of all the Santa Cruz department migrants have settled in District 6 and 10; District 8 has received more migrants from the highland departments of La Paz, Oruro, and Potosí; and District 12 has more migrants from Chuquisaca (Kirshner, 2009).

3.2.2 Defining Green Space

In this study, green space is considered any public outdoor space that offers amenities that provide social, health, environmental, and/or economic benefits to the users or the community. The spatial extent of these areas is primarily composed of permeable surfaces (e.g., grass, vegetation, trees, and water), with the exception of concrete sport fields and plazas, which generally have a mix of both permeable and impermeable surfaces. Although several of the large urban parks within Santa Cruz have open water access, the majority of water in Santa Cruz is either inaccessible or undesirable (e.g., Río Piraí *, curichis* (degraded wetlands), drainage canals) (Wright Wendel & Mihelcic, 2009).

3.2.3 Selecting Green Spaces

2001 census data, obtained from the Instituto Naciónal de Estadistica (INE), and a Geographic Information System (GIS) platform were used to evaluate socio-demographic differences within each district of Santa Cruz, as well as between inner and outer districts. Within each district, UVs (neighborhood units) were used to divide the districts into comparable units for analysis in ArcGIS version 9.3.1 (Florida State University, 2010). All UVs were populated with socio-demographic data that included gender, age, literacy, education, occupation, ethnicity, access to basic services, and poverty.

Differences in poverty, ethnicity, and access to basic services were used to select green space locations for interviews and observations, which helped to ensure a representative sampling throughout the city. Direct systematic observations of park use and activities were conducted in 281 green spaces throughout the city[2]. Information was collected on the number and type of users, activities engaged in, amenities offered, and overall appearance and maintenance (park use and activity data can be obtained from authors). A geodatabase was created using ArcGIS to evaluate spatial and physical attributes of each visited green space. This quantitative data was used to triangulate data from interviews and observations (described below), as well as document broader trends in green space access.

3.2.4 Observations and Interviews

Qualitative and quantified data were gathered using participant observation and semi-structured interviews during three site visits to Santa Cruz between June 2009 and June 2010 (Schensul et al., 1999). In order to provide systematic documentation of the range of activities and green spaces throughout the city, various types of green spaces (e.g., parks, plazas, open areas) were visited on different days of the week and during various times of the day throughout the city (a total of 500 green spaces were observed during the three site visits). To access these spaces, all transportation options (e.g., walking, micros (public transit buses), taxis, and private transportation) were utilized to gain a better understanding of the different time and economic constraints imposed by each option.

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[2] The systematic green space observation data sheets can be obtained directly from the author.

Green spaces were separated into two categories according to local conventions – large urban parks (LUPs) and small neighborhood parks (SNPs). The 12 districts in Santa Cruz were also differentiated into two separate categories according to the level of access to basic services (e.g., sanitation, potable water) and poverty, as reported in the 2001 census – 1) *Inner Districts* with lower rates of poverty and greater access to basic services located within the 4^{th} Ring Road (districts 1-4 and 11) and 2) *Outer Districts* with higher rates of poverty and lower access to basic services located beyond the 4^{th} Ring Road (districts 5-10 and 12). Interviews were conducted in five LUPs (three inner districts and two outer districts), and in two groupings of SNPs (one inner district and one outer district). While the LUPs have similar amenities, many of these are not present in the SNPs; therefore, an area was selected that contained a moderately dense clustering of different types of SNPs (i.e., sports field, plaza, park, open space) to provide a more equivalent comparison with the LUPs.

In December 2009, 31 semi-structured interviews were conducted to pre-test the green space interview questions. In June 2010, a systematic sampling plan – based on observations and preliminary interviews – was used to conduct 108 interviews with green space users and potential users. Semi-structured interviews were conducted to obtain information such as use frequency, mode of transportation, average travel time, amenities used, perceived benefits, and barriers to use. More specific information was obtained with additional open-ended follow up questions. The interviews ranged from five minutes to one hour. Targeted interviews were also conducted with city planners, engineers, architects, and park guards. Table 5 provides a summary of the number of interviews and their locations, which reflects use patterns of the different green spaces as revealed by observation data (i.e., more interviews were conducted in LUPs and Inner District green spaces because of greater overall use compared to SNPs and Outer District spaces).

3.3 Results

3.3.1 Green Space Preference

As described above, systematic observations were conducted to characterize green spaces and their use around the city, during different times of the day and days of the week. Table 6 provides data on attributes of the green spaces visited. The large urban parks had the highest average number of acres per park (an average of 15 acres for inner district LUPs and 10 acres for outer district LUPs) and the best maintenance and appearance, with the small neighborhood parks having the lowest number of average acres and average maintenance. The average size of the Inner District green spaces (4 acres) was larger than the Outer Districts spaces (3 acres), which are located beyond the 4^{th} ring (Figure 7). Furthermore, the LUPs and Inner District spaces had more playgrounds, tree cover, and benches than the SNPs and Outer Districts green spaces, respectively. Several of the LUPs also had water features (e.g., lake, water fountain, wetland) that were absent from the SNPs.

Table 5. Interviews conducted in Santa Cruz by green space type and location, day of week, and time of day.

Interviews	**All Parks**	**Large Urban Parks**	**Small Neighborhood Parks**	**Inner Districts**	**Outer Districts**
Total	108	73	35	63	45
Weekday	55	29	26	33	22
Weekend	53	44	9	30	23
Day	90	70	20	52	38
Night	18	3	15	11	7

Note. Day is before 5 pm; Night is after 5 pm

Table 6. Attributes by type and location of green space, including average number of desirable amenities, obtained from park counts.

	All Parks	**Large Urban Parks**	**Small Neighborhood Parks**	**Inner Districts**	**Outer Districts**
Total Parks	281	17	264	94	187
Average area (acres)	3	12	2	4	3
Maintenance/appearance	Average	Excellent	Average	Average	Average
Parks with playgrounds	43%	82%	41%	47%	42%
Tree cover	15%	32%	14%	20%	12%
Impervious surfaces	19%	40%	18%	24%	17%
Average number of amenities					
Playgrounds	1	3	1	1	1
Benches	14	92	9	16	12
BBQ pits (group areas)	1	8	0	1	2

Table 7. Average and normalized (visitors per average acre, denoted with parentheses) number of green space users by type, location, time of day, and day of week, obtained from 281 systematic green space observations in Santa Cruz (Bolivia).

Average Number of Users		**All Parks**		**Large Urban Parks**		**Small Neighborhood Parks**		**Inner Districts**		**Outer Districts**	
		Day	**Night**	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**
All Users	Total	22 (8)	35 (12)	110 (9)	133 (11)	11 (7)	16 (10)	35 (9)	65 (18)	15 (6)	19 (8)
	Male	15 (5)	17 (6)	63 (5)	79 (6)	7 (5)	12 (7)	21 (6)	38 (10)	10 (4)	11 (5)
	Female	9 (3)	12 (4)	48 (4)	54 (4)	4 (2)	5 (3)	14 (4)	27 (7)	5 (2)	8 (3)
Children		5 (2)	7 (2)	23 (2)	25 (2)	3 (2)	4 (3)	5 (1)	11 (3)	5 (2)	6 (2)
Youth		5 (2)	8 (3)	21 (2)	38 (3)	3 (2)	4 (3)	7 (2)	19 (5)	4 (1)	5 (2)
Elderly		1 (0)	1 (0)	7 (1)	7 (1)	0 (0)	0 (0)	2 (1)	5 (1)	0 (0)	1 (0)
Families		1 (0)	1 (0)	4 (0)	5 (0)	0 (0)	0 (0)	1 (0)	3 (1)	0 (0)	0 (0)
Guards		0 (0)	0 (0)	3 (0)	2 (0)	0 (0)	0 (0)	1 (0)	1 (0)	0 (0)	0 (0)
		Weekday	**Weekend**	**Weekday**	**Weekend**	**Weekday**	**Weekend**	**Weekday**	**Weekend**	**Weekday**	**Weekend**
All Users	Total	22 (7)	29 (10)	79 (6)	144 (12)	13 (8)	15 (9)	13 (8)	67 (18)	16 (6)	16 (7)
	Male	13 (5)	18 (6)	48 (4)	84 (7)	8 (5)	10 (6)	17 (5)	40 (11)	10 (4)	11 (4)
	Female	8 (3)	11 (4)	31 (3)	60 (5)	5 (3)	5 (3)	11 (3)	27 (7)	6 (2)	6 (2)
Children		5 (2)	7 (2)	14 (1)	22 (2)	3 (2)	5 (3)	4 (1)	33 (9)	12 (5)	12 (5)
Youth		5 (2)	7 (2)	17 (1)	36 (3)	3 (2)	4 (2)	6 (2)	16 (4)	4 (2)	4 (2)
Elderly		1 (0)	1 (0)	4 (0)	10 (1)	1 (0)	0 (0)	2 (0)	4 (1)	1 (0)	0 (0)
Families		0 (0)	1 (0)	1 (0)	6 (0)	0 (0)	0 (0)	0 (0)	2 (1)	0 (0)	1 (0)
Guards		0 (0)	0 (0)	2 (0)	2 (0)	0 (0)	0 (0)	1 (0)	1 (0)	0 (0)	0 (0)

Note. Children are under 12; Youth are 13-20; and Elderly are over 50.

Previous research (from industrialized nations) suggests that green space users prefer nearby, attractive, and larger areas (Giles-Corti et al., 2005). Data obtained from the systematic observations (as well as interviews and participant observation, discussed below) is in agreement with these findings – Santa Cruz residents prefer to use the LUPs over the SNPs, which have a higher number of average acres, better maintenance, and more amenities. However, although SNPs may be less appealing to use, they are typically located closer to many residents and are therefore used with similar frequency as the LUPs, relative to their size (as indicated by the normalized number of users in Table 7). In this case, data is normalized on a visitor per acre basis. Overall, green spaces were used more frequently after 5 pm as well as on the weekends, with the exception of Outer District spaces that had similar weekend and weekday use. Each category also had a generally higher use of green space by males than by females, regardless of the user group.

Table 8 provides the characteristics of the 108 interview respondents. While there was some variation between respondents interviewed in LUPs and SNPs, the majority were females, in their 30s or younger, had an average-level income, lived in an outer district, relied on *micros* (public transit buses) or walking, used green space socially (with family, friends, significant others), and were regular or intermittent users. Although males were identified as using green spaces more than females, differences in how each gender uses green space (generally more active or individual use by men and social use by women) and a greater willingness to participate by women resulted in more interviews being conducted with women.

Table 8. Characteristics of interview respondents (by percentage), including green space use and frequency (listed by location of interview).

Characteristics of Respondents		Large Urban Parks	Small Neighborhood Parks
Gender	Male	45.2	35.5
	Female	54.8	64.5
Age	<20	9.1	27.3
	20s	45.5	15.2
	30s	30.3	33.3
	40s	9.1	15.2
	>50	6.1	9.1
Income	Lower	22.7	27.3
	Average	68.2	72.7
	Higher	9.1	0
Location of Home	City Center	37.5	27.3
	Outer Districts	50.0	69.7
	Outside of city	12.5	3.0
Transportation to Green Space	Micro	45.5	40.6
	Taxi	15.2	3.1
	Walk	15.2	56.3
	Car	22.7	0
	Motorcycle	1.5	0
Travel Time	<5 min	27.0	51.6
	6-29 min	31.7	16.1
	30-59	19.0	22.6
	>1 hour	22.2	9.7
Use Frequency	Frequent	12.1	18.2
	Regular	39.4	30.3
	Intermittent	24.2	27.3
	Irregular	19.7	18.2
	Never	4.5	6.1
Use of Green Space	Social	86.4	84.8
	Alone	6.1	9.1
	Work	7.6	0
	Do not use	0	6.1

Note. Use frequency levels: Frequent – > 3 times/week; Regular – 1-2 times/week; Intermittent – 1-2 times/month; Irregular – < 1 time/3 months

3.3.2 Perceived Benefits of Green Space

The stronger preference for LUPs over SNPs can be better understood by examining the differences in perceived benefits and local perceptions of what constitutes desirable green space attributes. Open-ended questions allowed respondents to identify in their own words what they considered to be desirable attributes. In LUPs, these included atmosphere/ambiance (18%), large space or more amenities (17%), and the presence of vegetation, trees, shade, fresh air, and/or water (15%); whereas SNP respondents more frequently listed amenities for children (24%), social gathering sites or places to cook (14%), and proximity to home (14%).

The perceived green space benefits identified by interview respondents were similar to those identified in industrialized contexts (Chiesura, 2004) and included places to relax, socialize, allow children to play, and enjoy fresh air, trees, and shade (Table 9). The younger age groups more frequently used green spaces for recreation and meeting other people, while the older age groups preferred green spaces for escaping the stresses of daily demands, allowing children to play, and enjoying natural amenities (e.g., trees, shade, fresh air).

Table 9. Green space benefits perceived by interview respondents (percentages listed by location of interview).

Benefits of green space	Large Urban Parks	Small Neighborhood Parks
Place to relax	33.6	28.3
Place to socialize	21.9	34.8
Place for children to play	17.2	26.1
Fresh air/trees/shade	12.5	4.3
Place to get out of the house	5.5	6.5
Place to recreate	3.1	10.9
Access to open space/nature	2.3	0
Place to learn more about country	1.6	0
Place to experience wildlife	0.8	0

3.3.3 Accessibility and Usability of Green Space

Despite the strong preference for LUPs by residents, access to these spaces, particularly during the week, is often limited by several factors. Observations and interviews revealed that transportation availability often determines the type of green space residents have access to. For example, many residents who rely on public transit (*micros*), but not located within walking distance to a LUP, must take one or more micros, requiring a minimum of 30 minutes to over one hour (each way). As shown in Table 10, the majority of green space users rely on micros or walking, with average travel times of 44 and 4 minutes, respectively. In general, respondents were willing to walk up to five minutes to reach green space (corresponding to 400 m), which is a commonly accepted access distance (to green space) in the industrialized nation literature (Boone et al., 2009).

Table 10. Transportation method used by interview respondents to access green space, including average travel time, by type and location of green space.

	All Parks		Large Urban Parks		Small Neighborhood Parks		Inner Districts		Outer Districts	
Transport Method	**% of Total**	**Travel Time[1]**	**% of Total**	**Travel Time**	**% of Total**	**Travel Time**	**% of Total**	**Travel Time**	**% of Total**	**Travel Time**
Taxi	10%	13	14%	12	3%	20	12%	15	9%	10
Micro	43%	44	46%	47	38%	38	59%	43	22%	48
Motorcycle	1%	45	1%	45	0%	-	0%	-	2%	45
Walk	31%	4	18%	5	59%	4	21%	5	44%	3
Car	14%	23	21%	23	0%	-	8%	28	22%	20

[1]Average travel time (minutes)

3.3.4 Barriers

Despite recent green space improvements in Santa Cruz, negative perceptions remain for many SNPs and a few older LUPs due to differences in quality, size, and maintenance. Respondents found the following attributes to be undesirable: smaller spaces or a lack of amenities, dangerous or unsafe conditions (i.e., lack of guards, lighting, and people), poor maintenance, and a lack of vegetation, which is in agreement with findings from previous studies (Boone et al., 2009; Crompton, 2001).

Safety was the primary barrier that limited green space accessibility or use, particularly for females (Table 11). In general, respondents felt more comfortable in LUPs than SNPs because the latter are not well-lit, patrolled, or well-maintained. However, SNPs that are considered safe during daylight hours were perceived as dangerous at night due to problems with substance users, robberies and gangs. Furthermore, these problems existed at any time in spaces with no guards and fewer visitors. Additional barriers included distance, access to desirable green spaces, and time, although the prevalence of these barriers varied between LUPs and SNPs.

Table 11. Existing barriers to accessing or using green space identified by interview respondents (percentage listed by location of interview).

Barriers to using green space	Large Urban Parks	Small Neighborhood Parks
Safety	42.4	65.0
Distance	24.2	0
Access to desirable green space	18.2	5.0
Time	15.2	30.0

3.4 Discussion

Within Santa Cruz, green spaces are primarily classified into two main types: large urban parks (LUPs) and smaller neighborhood parks (SNPs). The LUPs were created to improve safe public access to larger green spaces within each district and offer more amenities for all age groups as a way to enhance quality of life in this rapidly urbanizing city. Due to the direct link found between increased levels of crime and high levels of inequality and insufficient green space (UN-HABITAT, 2008), the creation of the LUPs in Santa Cruz may help improve equitable green space access while also decreasing crime.

Despite the addition of at least one LUP in each district (some inner districts have more than one) since 2006, the majority of respondents still felt that there was a lack of safe or desirable green space near their home. In the outer districts for example, many of the green spaces are sport fields that tend to be dominated by males and team-oriented groups, and are often viewed as unattractive spaces for women, elderly, or individuals interested in more passive amenities. Therefore, these active-only spaces are under-utilized the majority of the time. In general, many do not consider small green spaces as useable because they have few or no desirable amenities, are poorly maintained, patrolled, and/or lit, and may have problems with substance users, robbers, or gangs, which increases the negative perceptions of these spaces. The presence of guards and fences (which restricts the number of entrance and exit points – often near guards) in the LUPs was perceived as an effective means for deterring illicit activities and improving safety. This was found to be very important for breaking down access barriers by encouraging green space use by families and women, the latter of which were under-represented in the systematic green space observations. According to one female respondent, "when there are guards, there is no fear."

Green space quality and the number of amenities offered was found to differ more significantly for SNPs than LUPs, and typically depended on whether they were located in the wealthier inner districts or the less developed outer districts. For example, LUPs located in the outer districts tend to be smaller, less centrally located (i.e., located in the middle of a neighborhood, not along a major road), and occasionally had fewer overall amenities. This is similar for the SNPs – outer district spaces are often smaller, less safe (less lighting, less patrolling, fewer users), less maintained, and dominated by sport fields.

Previous studies have found that trees, water, good maintenance, and a relaxed atmosphere are preferred features; while man-made objects, poor maintenance, congestion, and large monotonous fields were found to reduce the appeal of green spaces (Nicol et al., 2000). Many higher-income residents, who were primarily observed and interviewed using LUPS, typically own a private vehicle which improves access to more desirable green spaces within Santa Cruz, but also allows them to recreate outside of the city on the weekend or holidays. However, lower-income residents are limited to urban green spaces within Santa Cruz for their recreation and leisure activities. According to interview respondents, prior to the addition or revitalization of the LUPs, many of the amenities offered in these spaces did not exist. As a result, respondents indicated that the addition of the LUPs has motivated more residents to seek out and utilize green spaces within Santa Cruz, although this was primarily noted for the LUPs. Based on interviews with many first time green space users, the increase in the number of LUPs may be helping to reduce barriers to using these spaces (i.e., providing greater access to desirable and safe spaces), thereby reducing leisure and recreational disparities between socio-demographic groups.

Not surprisingly, the desirable features of the LUPs (e.g., safe, variety of amenities, landscaped, well-maintained, open to the public) embody the benefits that many respondents perceive from green space, such as a place to relax, socialize, allow children to play, and enjoy nature. Many of the LUPs have large trees that create a micro-climate that allows users to escape the heat, pollution, and noise of the city, as well as cramped living conditions (Bolund et al., 1999). Furthermore, benches, social gathering sites, and walkways located amongst native vegetation in the LUPs may represent the only means of enjoying natural landscapes within the urban environment for many residents.

Despite the overwhelming preference for LUPs, distance and time are the primary barriers for accessing these spaces, and this was most apparent for outer district and lower-income residents. Therefore, although SNPs are less valued, during the week these spaces typically represent the only accessible spaces, assuming that safety and green space type do not create additional barriers to use. Observations and interviews revealed the presence of more barriers for women due to limited mobility, children, and significant domestic responsibilities. Whereas men, who represented the majority of green space users in the systematic observations, have greater mobility and fewer domestic responsibilities, which allow them to use green space more freely, either alone or socially. As a result, although nearby SNPs may not be as desirable or usable, these smaller spaces usually provide amenities for children, which allows women to relax, socialize, and take a break from their daily responsibilities. As one respondent commented, “everyone has their own particular way to relax; in their own manner, at their own convenience, because we all have different tastes.”

The issue of accessibility and usability was strongly influenced by whether barriers were present that limited an individuals’ time, sense of safety, travel distance, and ability for green space amenities to match user preferences. For higher-income or centrally located residents, many of these barriers are reduced or eliminated due to their access to private recreational amenities (within their homes or at private facilities), private transportation, or proximity. Improved access to desirable green spaces has been shown to increase the use of these spaces; thereby improving health and social cohesion (Maller et al., 2006). A variety of inequalities exist for lower-income and outer district residents in terms of access to quality green spaces, while many of the barriers identified by interview respondents are interrelated. Quality green space may be inaccessible due to one or all of the following: 1) lack of time, regardless of other access issues; 2) distance too great with available transportation options; 3) accessible spaces are undesirable (not maintained, lit, patrolled, or used by other residents); and/or 4) amenities in accessible spaces are not compatible with user preferences (e.g., active only amenities, which excludes use by women and elderly).

While Santa Cruz has taken significant steps to improve the quantity, quality, and safety of green space, the majority of these improvements have focused on the LUPs, with the construction of 11 new LUPs since 2006. According to residents, park guards, and city planners, these measures have been successful in reducing access barriers due the increased number of LUPs, uniform appearance and maintenance. Many residents now associate these spaces, which are easily identifiable, as being high quality, desirable spaces that are safe and available for all to use. This is in contrast with many SNPs, which due to differing levels of maintenance and amenities are perceived as being less desirable. Without safety improvements and increased diversity of amenities, these spaces will continue to be perceived as places to avoid. Many interview respondents reported feeling safe using green spaces if there were guards, families, or elderly users, but avoided places that primarily had adolescent users. While it would not be financially feasible to place guards in all of the small green spaces around the city, there are other improvements that could be made to improve safety, and ultimately the usability of these spaces. For example, future improvements should focus on increasing the variety of amenities, overall appearance, and lighting. This will help to encourage more user groups, and therefore, more total users, while also potentially infusing a sense of ownership by the local community that could result in better care of these spaces. For example, vandalism was prevalent in many of the less frequently used outer district SNPs; however, this was not the case in communities that had created a vested interest in the upkeep of their SNPs.

There is also a need to increase mixed-use public green spaces in many of the outer districts where sprawled development outpaces urban planning. Development in the peri-urban area is low-density and travel times are unreasonably long to many of the LUPs; therefore, these communities must rely primarily on SNPs for their green space exposure. Yet, in the outer districts, sport fields dominate green spaces – based on systematic observations, 67% of all SNPs in the outer districts were sport fields, versus

34% for inner district spaces. This then creates additional inequalities, as women and elderly are excluded from green space use by these active-only spaces.

Finally, barriers impacting green space access are most significant for lower-income and less centrally located residents. Less than one third of all Santa Cruz residents are able to satisfactorily meet their basic needs, which has resulted in disparities in access to goods and services such as health care, housing, education, and recreational opportunities (GMSC, 2007). Therefore, it is these lower-income residents who have the greatest need for the health, social, environmental, and economic benefits of green space. It is clear that the amenities and atmosphere of the LUPs are better able to satisfy the needs of all user groups. Therefore, the under-utilized potential of smaller green spaces could be harnessed by incorporating more desirable features. Only then will green space access become more equitable and its full benefits realized. Based on interviews and observations, many respondents indicated that the increase in highly desirable and safe green spaces throughout Santa Cruz is allowing more residents, particularly lower socio-economic groups, to overcome many access barriers (or at least providing greater incentives to overcome these barriers). This highlights the importance of green spaces as equalizers in urban areas with increasing levels of inequality.

Although several outcomes of this research were in agreement with those of studies from industrialized nations, there is a need to evaluate (and design) green spaces based on local geographical, economic, and cultural contexts. This is especially important because, according to the United Nations, over the next 40 years 2.3 billion people will be added to the global population in urban centers of developing countries. Although poverty and other inequalities are increasing more rapidly in urban areas than in rural areas, including the development of unplanned urban slums, cities typically have more opportunities to reduce poverty. However, this will require visionary planning that aims to improve residents' quality of life through good governance that incorporates public green space into the urban landscape (UN-HABITAT, 2008).

Chapter 4: Assessing Equitable Access to Urban Green Space: The Role of Engineered Water Infrastructure

4.1 Introduction

Green space includes natural or human-modified outdoor spaces, either publicly or privately owned, that are comprised of significant amounts of vegetation, water, and/or permeable surfaces (Budruk et al., 2009). These spaces facilitate hydrological processes in areas where urban development interferes with the movement, distribution, and quality of water (Niemczynowicz, 1999). They also provide social, health, environmental, and economic benefits to communities, some of which include increased levels of physical activity (Giles-Corti et al., 2005), filtration of water pollution (Boone et al., 2009), increased control of stormwater runoff and flooding (Hill, 2007), reduced loading on stormwater systems (Raucher et al., 2010), improved groundwater recharge (Sherer, 2006), provision of wildlife habitat (Ahern, 2007), and reduced need for pollution prevention measures (Callaway et al., 2010).

Around the world, urbanization, population growth, and the structuring of cities around the automobile have resulted in a low-density sprawl development pattern, which has caused a loss of green space, decreased non-motorized transportation, reduced physical activity, increased air and water pollution, and decreased community cohesion (Frumkin, 2002; UNFPA, 2007). Furthermore, urban sprawl has created numerous environmental justice issues due to the disproportionate impacts from environmental hazards on minority and low-income populations (Su et al., 2009). Additionally, a lack of mobility, which is particularly pronounced among lower socioeconomic groups, children, and the elderly, can reduce access to economic opportunities and recreational amenities (Leck et al., 2008). Inequities in the distribution of green space have also been associated with higher proportions of minorities, individuals with lower education, and higher poverty rates, which can lead to disparities in health-related behaviors and obesity (Kipke et al., 2007; Powell et al., 2004). Given the health benefits related to the contact or use of green space, Mitchell et al. (Mitchell & Popham, 2008) acknowledged that disadvantaged populations with green space access may obtain some protection from the effects of poverty-related stress, possibly decreasing their mortality rates relative to similar populations that lack access. There is also evidence that urban residents living in greener environments may be significantly more healthy than those living in environments with less green space (de Vries et al., 2003), and the presence of water may create even greater health improvements. For example, people exercising in all types of natural environments experienced enhanced self-esteem and mood, with the presence of water creating the greatest improvements (Barton & Pretty, 2010).

Unfortunately, the structuring of the urban landscape has often neglected the importance of natural landscape features, particularly water features, despite the fact that many urban areas were historically developed around water resources. With continued urbanization – an estimated 70% of the world's population is expected to reside in cities by the year 2050 (UNFPA, 2007) – urban hydrology will play an increasingly important role in the management of water resources and the sustainability of cities (Niemczynowicz, 1999). Yet historically water management has been compartmentalized, treating urban water resources as separate entities (i.e., water supply, wastewater, stormwater management). Additionally, conventional "grey" infrastructures such as pipes, channels, and drainage ponds have replaced ecosystem services and cycles ("green" infrastructure).

Although traditional urban water management approaches protect human health and property, engineered conveyance systems have concealed the urban hydrological cycle, as well as its management, from the public, which has led to a disconnect with stakeholders who have become wary of water reclamation and reuse (Macpherson, 2010). Obtaining the support of stakeholders, which starts with building a better understanding of, and therefore contact with, the urban water cycle, is vital to implementing sustainable water management. Fortunately the integration of green infrastructure, such as natural water features, open space, and parks, into urban water management has been shown to provide greater environmental, health, and social benefits than single purpose grey infrastructure (Ahern, 2007). However, many urban landscapes continue to be dominated by grey infrastructure such as stormwater ponds and drainage canals to which access is restricted, thereby reducing the use of potential green spaces and surface water features (McGuckin et al., 1995). Although urban water management (and infrastructures) differ according to geographic context (e.g., use of stormwater drainage ponds in Florida), there are unique solutions to enhancing the sustainability of each system through improved integration with natural and cultural features.

Previous studies have examined different aspects of green space access such as health, physical activity, and equality (Boone et al., 2009; Gordon-Larsen et al., 2006; Maas et al., 2006; Nicholls, 2001), while others have studied the environmental impact of green infrastructure such as rain gardens and green roofs (Andrew et al., 2008; Davis, 2005; Saiz et al., 2006). Yet few have examined the role of unconventional green spaces in the built environment, particularly urban water infrastructure, to improve access and reconnect residents to the urban watershed. As urban areas become more densely developed, there will be a greater need to utilize these unconventional spaces for broader social and environmental purposes. By improving the understanding of, and contact with, urban water cycle management, a greater environmental awareness and stewardship can be fostered, as well as a better connection between stakeholders and critical issues of watershed protection and water reuse (Macpherson, 2010). This has long-term implications for enhancing urban quality of life while also decreasing economic and environmental costs of providing integrated water infrastructure to an urbanizing world (Maheepala et al., 2010).

In order to reconnect communities with a new paradigm of an integrated urban water hydrological system, new perspectives are needed to drive innovations in providing the infrastructure and social acceptance required to meet the future needs of increasing population, affluence, and urbanization (Boyle et al., 2010). Approaches for improving water management integration have emerged at various spatial scales (e.g., low impact development, smart growth, and integrated urban water management). They provide examples of how improved integration of urban water infrastructure with the provision of green space can enhance social amenities while also providing environmental functions and economic benefits (Maheepala et al., 2010; Marsalek et al., 2007).

This research examines existing and potential green space access, particularly for spaces with natural and urban water features, within Tampa and the East Tampa

Community Redevelopment Area. The ultimate goal is to identify any disparities in existing access, particularly for low-income and minority residents that have historically been subject to inequitable distribution of environmental risk and urban amenities, and evaluate the ability for enhanced urban water infrastructure to reduce access disparities. Three development scenarios were analyzed to evaluate the impact of integrating green and grey infrastructure to improve green space and water access. The first scenario, the "greening" of all stormwater ponds within the city of Tampa, was designed as a best case scenario to evaluate the under-utilized potential of existing urban water infrastructure. Two other scenarios analyzed improvements in green space and water access through the revitalization of a relatively few, but strategically located, stormwater ponds within the inner city area of East Tampa. This "greening" of engineered water infrastructure is proposed to address both environmental justice issues as well as to reconnect residents with the urban water cycle and its management.

4.2 Materials and Methods

4.2.1 Study Area

The Tampa-Clearwater-St. Petersburg Metro area has undergone some of the most rapid development in the U.S. in the last three decades (U.S. Census Bureau). This subtropical area is water scarce for many months of the year, with a population learning to face water shortages, and characterized by seasonal precipitation – almost 60% of the total yearly rainfall (average of 44.8 inches) occurs between June and September (Florida State University, 2010).

Within the city of Tampa, nine areas are designated as Community Redevelopment Areas (CRAs). The CRA designation provides a means for stimulating redevelopment in these often older, low income communities (City of Tampa, 2003). East Tampa, the largest CRA (Figure 8), was designated due to the presence of slum and blight conditions (e.g., high rates of vacancy, deteriorating structures, crime, and poverty). Although East Tampa has a variety of amenities – there are over 14 neighborhoods, 100 churches, and 29 schools within its boundaries – there are also many burdens and socio-demographic inequalities (Table 12). For example, it is bounded by two interstates, which contribute to air quality that is worse than surrounding communities (Stuart et al., 2009). There are also more than 40 stormwater drainage ponds and 500 contaminated or brownfield sites within East Tampa. Although typically viewed as eye sores, stormwater ponds represent under-utilized potential – two ponds were redeveloped into community lakes that are now widely used for social and recreational purposes ("East Tampa Strategic Action Plan", 2009). In this study, four main areas are referenced: 1) the entire *City of Tampa* ; 2) *Tampa* (sub-area excluding CRAs); 3) *CRAs* (sub-area excluding East Tampa), and 4) *East Tampa* (sub-area of CRAs). The data analysis focuses on *Tampa* (item 2) and *East Tampa* (item 4).

Table 12. Socio-demographic and land use characteristics of Tampa and East Tampa (City of Tampa, 2003; ESRI, 2000; Florida Geographic Data Library).

Socio-demographic Data	**East Tampa**	**Tampa**
Population (% total population)	30,928 (9.5%)	286,749 (88.3%)
% White population	19.7 %	69.4 %
% Black population	59.7 %	20.6 %
% Hispanic population	14.4 %	19.2 %
% Youth population (< 18)	31.0%	23.9%
% Elderly population (> 65)	13.2%	12.6%
% Housing Vacancy Rate	14.9%	7.6%
% Owner Occupancy Rate	51.7%	50.8%
Park acres per 1,000 residents	2.7	20.7
Residents per park acre	371	49

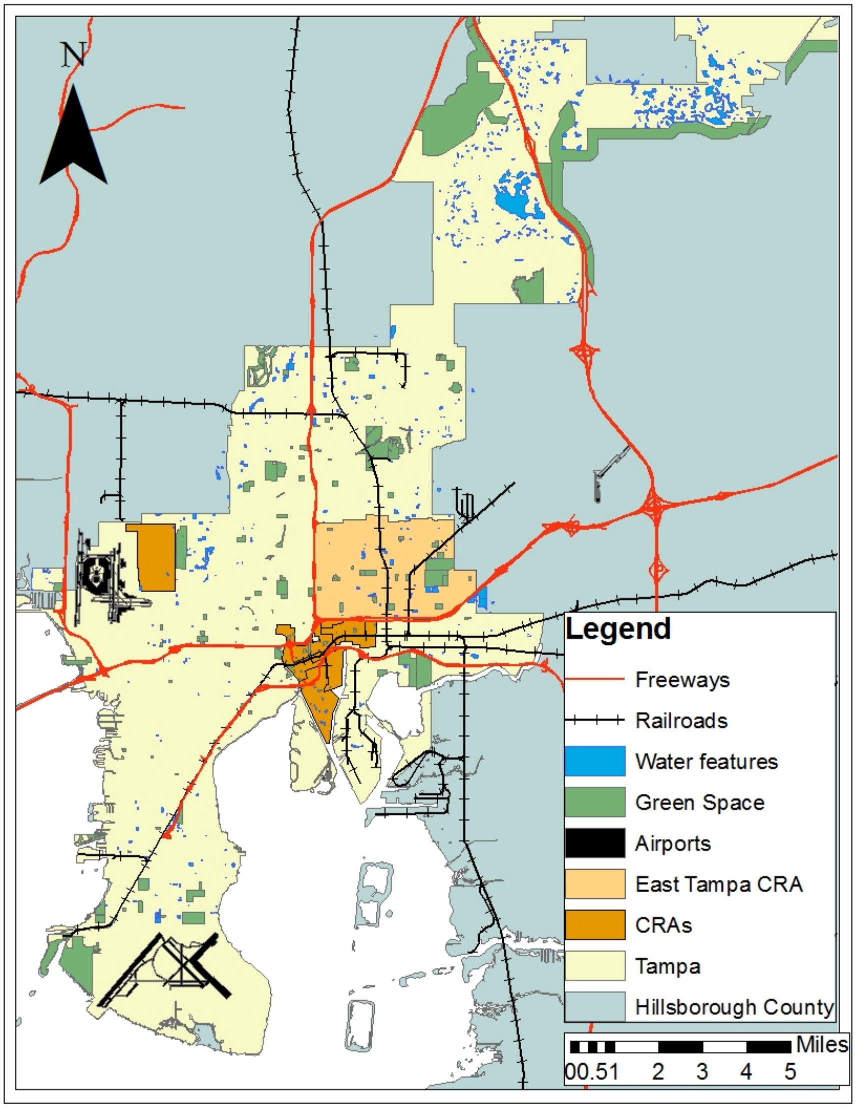

Figure 8. City of Tampa highlighting the location of the Community Redevelopment Areas (CRAs), green spaces, and water features (natural water and urban water infrastructure).

4.2.2 Defining Green Space

Green space was classified in this study as private if use was restricted by a fee (e.g., pools, theme parks), required a membership (e.g., private golf course, tennis club), or not permitted by the general public (e.g., private land). Public green space includes land uses where access is unrestricted and free to the public (e.g., parks, recreational facilities, open space, cemeteries). Golf courses that allow public access for activities such as walking, running, or dog walking, were included as public green space. Water features included both natural water (e.g., riverfronts, beaches, lakes) and urban water infrastructure (e.g., stormwater ponds). All public green space (herein *green space*) was identified (City of Tampa, 2009c; Florida Geographic Data Library) and populated with key attribute information: (i) presence of surface water features, (ii) types of amenities (passive, active), (iii) public transit access, and (iv) size (City of Tampa, 2009a). Using the attribute information, each space was classified and subdivided into one or more categories to examine differences in green space access and quality (Figure 9). Three main categories of green spaces were analyzed (Table 13): 1) traditional green space (pocket, neighborhood (NBHD), regional, and large parks; spaces accessible via alternative transportation), 2) green spaces with water features (natural water and urban water infrastructure), and 3) total public green space (traditional and unconventional green space).

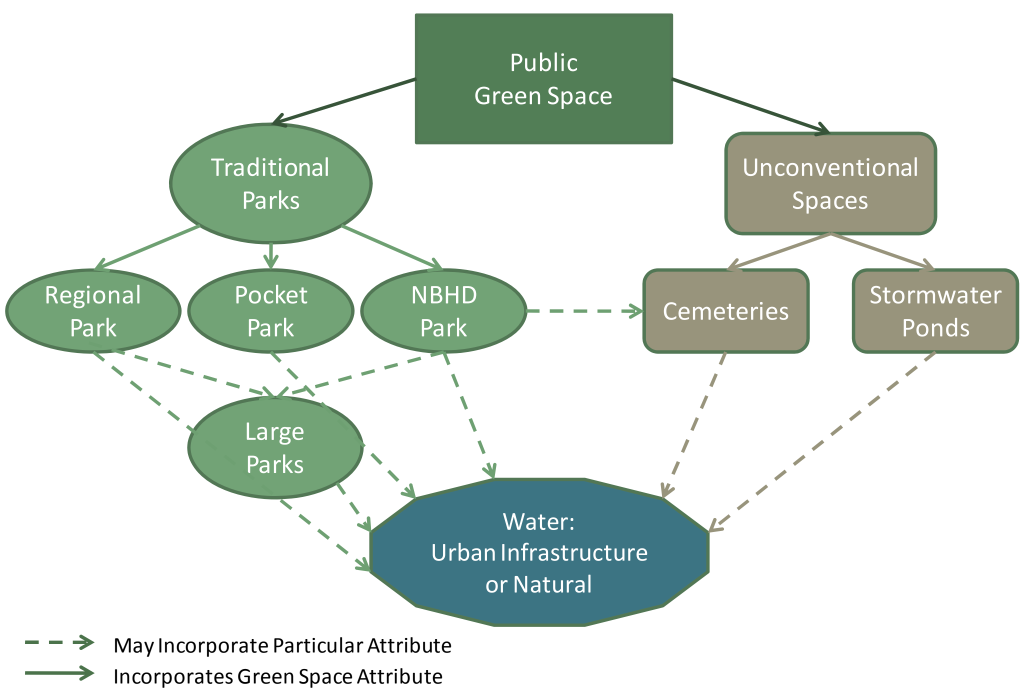

Figure 9. Types of, and connections between, public green space, including urban water infrastructure and natural water features in Tampa, Florida.

Table 13. Green space types, description and defined access distances used in this study (City of Tampa, 2008; Nicholls, 2001).

Type of Green Space		**Description**	**Access Distance**
Traditional	Pocket Park	Small landscaped informal spaces with limited passive amenities and no active amenities or facilities	¼ mile (400 m)
	Neighborhood (NBHD) Park	Landscaped spaces of varying size with passive and active amenities and facilities; located within residential areas	½ mile (800 m)
	Regional Park	Large landscaped and/or natural spaces with a wide range of amenities and facilities; access primarily via car	1 mile (1,600 m)
	Large Park	Spaces greater than 20 acres	½ mile
	Public Transit	Green space with one or more bus stops within a quarter mile	¼ mile
	Walkable	Green space within walking distance to one or more CBGs	¼ mile
Water	Natural Water	Contains natural water features (i.e., bay, river, lake)	¼ mile
	Urban Water Infrastructure	Water features designed for stormwater management; may or may not offer social amenities	¼ mile
	Total Water	Both natural and urban-infrastructure water features	¼ mile
Public	Traditional	Parks, playgrounds, outdoor recreation facilities, open space	¼ mile
	Unconventional	Urban water infrastructure and/or cemeteries	¼ mile

4.2.3 Measuring Green Space and Water Accessibility

The accepted distance that individuals are willing to walk to reach green space (i.e., access distance) is about a quarter mile (400 m), or approximately a five-minute trip (Boone et al., 2009). At distances greater than half a mile, individuals are more likely to drive – distance and time are the primary barriers for not walking (Lindsey et al., 2001). When green spaces are located beyond walking distance, these areas become destinations, and their use for spontaneous or frequent recreation is often reduced. However, access distances vary depending on the type of green space. As shown in Table 13, the access distances for regional, neighborhood, and large parks were the only green space types assumed to be greater than a quarter mile in this study.

A variety of methods can be used to measure access to green space, with each differing in complexity and in defining what constitutes "user access". Three methods were used to evaluate different measures of green space and water accessibility within Tampa and East Tampa: 1) container approach, 2) service area analysis, and 3) minimum distance analysis (Boone et al., 2009; Talen, 2003).

The container approach method was used to establish a baseline measure of green space availability within each study area. This approach quantifies all green space in a specified area, with the assumption that the more green space, the greater the potential access. In both study areas, the total number of acres was determined for all green space types as well as the relative percentage of each type. The total acres of public and traditional green space were normalized by the population of each area to evaluate aggregate access (acres per 1,000 residents). The benefit of this approach is that it provides a common measure to compare potential access of different areas. However, because accessibility does not always translate into usability, the major limitation of this method is that it does not take into account the spatial distribution, quality, or type of green space (Sister et al., 2007).

A second measure of accessibility involved delineating service areas around each green space to determine the portion of the population with access. This method was selected because it allowed differences in access (between socio-demographic groups), spatial distribution, and green space type to be evaluated. Service areas were defined by placing a buffer, based on access distance, around each green space (Table 13). Census block groups (CBG) whose population centroids were located within the service areas were assumed to have access. Although the portion of the population with or without access was estimated using this method, it assumes equal access along the green space boundary (Nicholls, 2001). Therefore, the issue of preference or other potential access barriers are not necessarily taken into account. To address these limitations, different green space types and access distances were included to determine whether disparities exist within the two study areas.

Lastly, a minimum distance analysis was used to determine the distance from a CBG population centroid to the nearest green space. This analysis, which takes into account all green space types, determines the Euclidean distance to the nearest type of green space from each CBG centroid, as well as provides a count of which types are closest to the population centroids. This analysis was utilized to remove pre-defined service areas and provide an average access distance for each CBG centroid within both areas.

4.2.4 Socio-Demographic Analysis

Using 2000 census data (ESRI, 2000), access to each type of green space was evaluated for the following eight socio-demographic groups: 1) Elderly (> 65), 2) Youth (< 18), 3) Single parents, 4) Whites, 5) Blacks, 6) Hispanics, 7) (Home) Owners, 8) and Renters (Figures 10 and 11). Many of these groups, with the exception of Whites and Owners, were selected based on previous studies that identified a relative lack in access to, or a greater need for, easily accessible green spaces (Kipke et al., 2007; Leck et al., 2008). Housing tenure (Owner versus Renter) was used as a proxy for income data, which is not available at the CBG level (Nicholls, 2001).

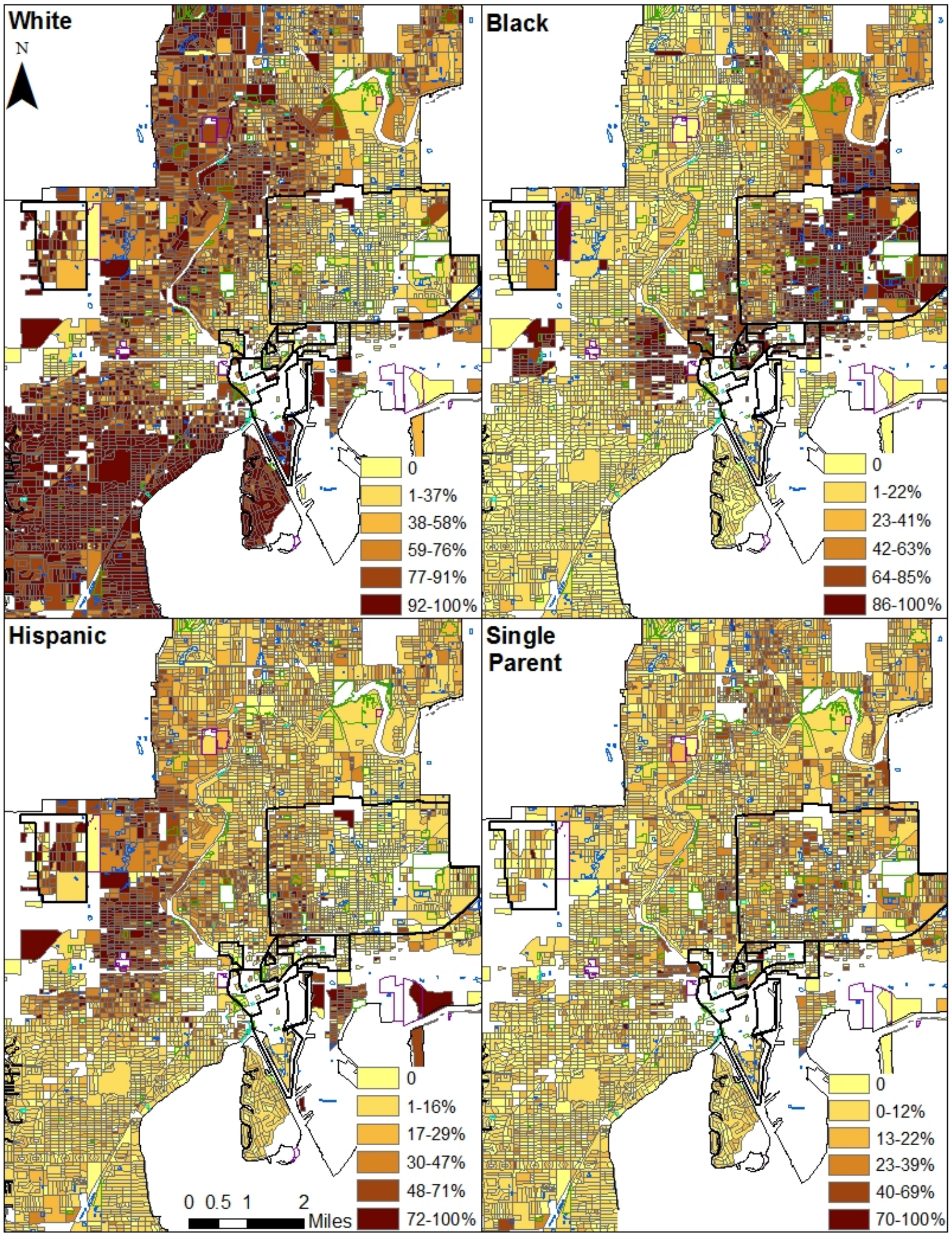

Figure 10. Population of Whites, Blacks, Hispanics, and Single Parents within the City of Tampa relative to the total population.

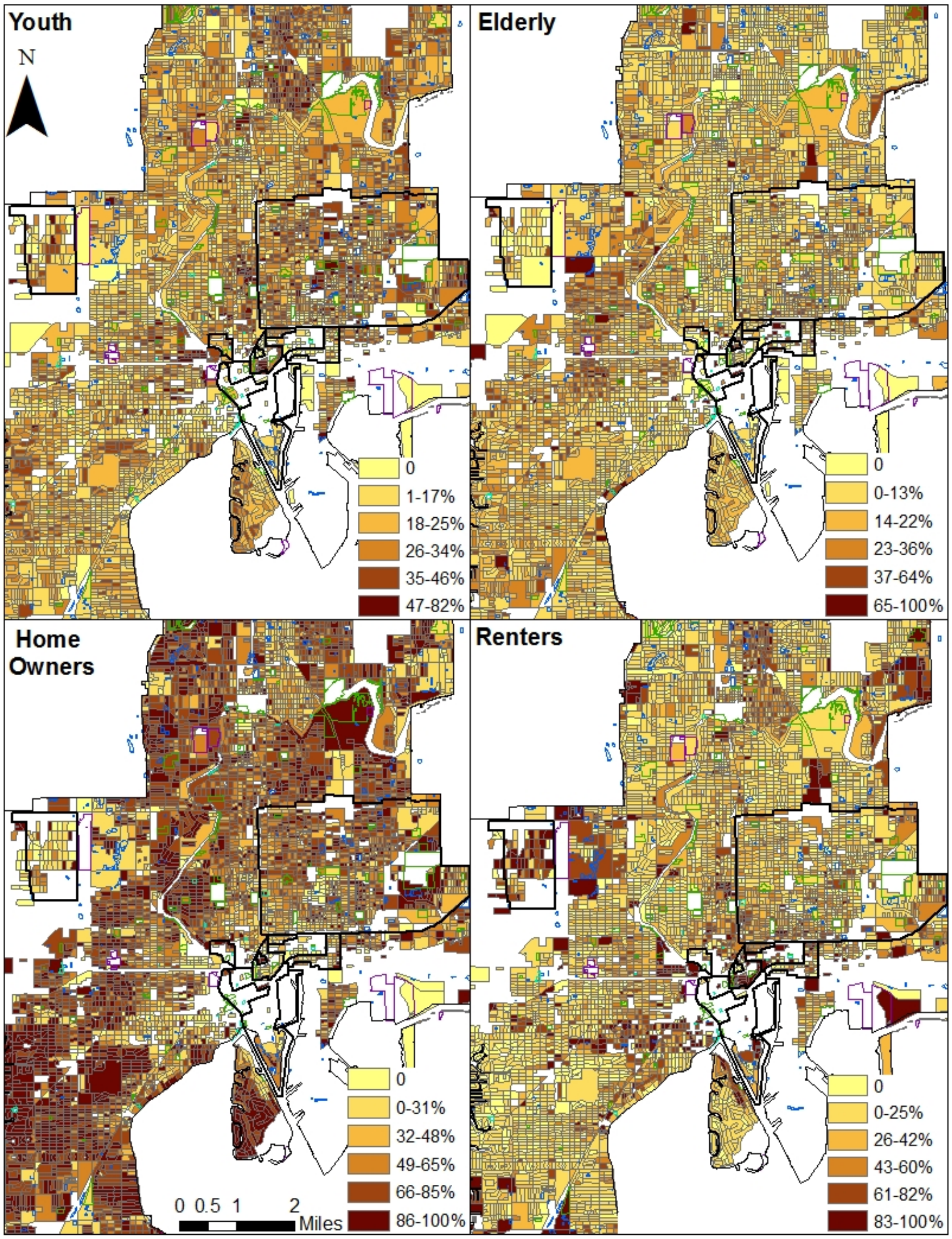

Figure 11. Population of Youth, Elderly, Home Owners, and Renters within the City of Tampa relative to the total population.

The total population and sub-population of each group with green space access were summed to provide the percentage with access within each area. Relative access is defined as the portion of individuals with access to green space relative to the total population, and was determined for each socio-demographic group by dividing the sub-population with access by the total area population with access for each type of green space. These relative access percentages (average access equals 100%) were then used to differentiate six levels of access, which were assigned corresponding scores (Table 14). Overall access was determined for each socio-demographic group by averaging the scores from all green space types using an equal-interval scale. This scale was defined by first calculating the total possible access score of each category (traditional green space, water, and public green space), which involved multiplying the number of green space types within each category by five (the highest possible score), and then dividing the total score by six (the number of access levels). The resulting two scales (one for the traditional green space category which has six different types of green space, and another for the water and public green space categories which have three each) have six equal intervals, which correspond to the six levels of access.

Table 14. Scale used to differentiate levels of green space access based on relative access by each socio-demographic group.

Level of Access	Relative Access	Score	Overall Access
Poor	*<75%*	0	
Marginal	*75-89%*	1	Assigned based
Fair	*90-99%*	2	on equal-
Good	100-109%	3	interval scale
Excellent	110-124%	4	*(see text)*
Outstanding	>125%	5	

Note: *Italics* indicate lower access than average total population

4.2.5 Development Scenarios

Three development scenarios were evaluated (using a quarter mile service area) to analyze changes in green space and water access by enhancing urban water infrastructures with social and environmental amenities. The first scenario (T1) assumed a greening of all stormwater ponds within the City of Tampa (i.e., fences removed, benches or walking paths added, enhancement of natural features, and year round water), thereby converting these spaces from unconventional to traditional green space. This represents a best case scenario for improving walkable access to traditional green space and water features using existing infrastructure.

The second and third scenarios focused on strategic stormwater pond enhancement within East Tampa, which currently lacks natural water features. Areas deficient in traditional green space were identified in ArcGIS by overlying the census data with the green space service areas; stormwater ponds were then identified within these "access gaps". The East Tampa development scenarios included enhancing: (ET1) four large, centrally located ponds (one 16 acres and three 3-5 acres), and (ET2) three small, dispersed ponds (each less than 1 acre). Two of the ponds in ET1 contain significant amounts of natural features and open water – features currently lacking or inaccessible within East Tampa; however, depending on the level of enhancement, the revitalization of these four large ponds may be cost prohibitive. Therefore, ET2 represents a less expensive option that also provides increased access to natural features and open water.

4.3 Results

4.3.1 Overall Green Space Access

Although both areas have similar quantities of green space relative to total land area (8.9% for Tampa, 8.3% for East Tampa), the average traditional green space in Tampa is six times larger than in East Tampa (Table 15). Additionally, the aggregate access (acres per 1,000 residents) for Tampa is more than double that of East Tampa, and almost eight times greater for traditional green space. The green space available within East Tampa also lacks diversity– 87.2% of traditional green spaces are neighborhood parks and 79.1% of total public green spaces are unconventional spaces. Tampa also has more green spaces with water features than East Tampa (93.6% vs. 72.7%) – particularly natural water features (68.7% vs. 0%), but also urban water infrastructure (16.9% vs. 12.0%). Yet access to natural water features was low within both Tampa (12.6%) and East Tampa (2.5%) relative to access to urban water infrastructure (48.7% and 52.3%, respectively) (Tables 16 and 17).

Table 15. Comparison of the quantities of green space and overall access for Tampa and East Tampa.

	Tampa	East Tampa
Total Area (acres)		
Total land area (% total)	81,466 (91.9%)	4,811 (5.4%)
Total public green space (% total)	7,224 (8.9%)	398 (8.3%)
Total traditional green space (% total)	5,948 (7.3%)	84 (1.7%)
Average total public green space size	75	8
Average traditional green space size[1]	108	18
Aggregate Access (acres/1,000 residents)		
Public green space	25.2	12.9
Traditional	20.7	2.7
Percent of Green Space by Type		
Total Traditional	*82.3%*	*21.0%*
Pocket Parks	0.8%	0.8%
Neighborhood Parks	14.3%	87.2%
Regional Parks	68.0%	0%
Large Parks (>20 acres)	76.5%	0%
Total Water	93.6%	72.7%
Natural Water	68.7%	0%
Urban Infrastructure	16.9%	12.0%
Cemeteries	0.8%	67.1%
Access by Green Space Type (% population with access)		
Pocket Park	7.0%	3.8%
Natural Water	12.6%	2.5%
Public Transit	33.5%	62.9%
Large Parks	37.2%	0%
Traditional Green Space	37.2%	53.3%
Walkable	37.9%	62.9%
Regional Park	48.6%	1.9%
Water Infrastructure	48.7%	52.3%
Unconventional Green Spaces	50.4%	56.7%
Neighborhood Park	60.3%	95.6%
Total Water	60.4%	69.1%
Total Public Green Space	70.4%	80.3%

[1]Includes cemeteries

Table 16. Percent access – both total and relative – for each demographic group and green space type within Tampa (excluding the CRAs).

Traditional Green Space Access	**% Population with Access**	**White**	**Black**	**Hispanic**	**Elderly**	**Youth**	**Single Parents**	**Owners**	**Renters**
Pocket Park	7.0%	*0.88*	1.42	*0.86*	1.15	*0.97*	1.03	*0.94*	1.03
Large Parks	22.9%	*0.93*	1.15	1.14	*0.88*	1.13	1.21	*0.95*	*0.95*
Public Transit	33.5%	*0.90*	1.31	1.13	1.02	1.06	1.22	*0.99*	*0.98*
Walkable	37.9%	*0.99*	1.03	1.08	1.01	1.01	1.03	1.02	*0.99*
Regional Park	48.6%	*0.98*	1.00	1.21	1.02	1.00	1.01	*0.98*	1.01
Neighborhood Park	60.3%	*0.95*	1.19	1.11	1.05	1.04	1.13	1.04	*0.95*
Water Access									
Natural Water	12.6%	*0.91*	1.27	1.06	*0.87*	1.09	1.27	*0.87*	1.10
Infrastructure	48.7%	1.00	*0.96*	1.02	*0.96*	*0.99*	1.00	1.00	1.02
Total Water	60.4%	*0.98*	1.04	1.01	*0.96*	1.02	1.08	*0.97*	1.05
Public Green Space Access									
Traditional	37.2%	*0.92*	1.26	1.08	1.01	1.06	1.18	1.00	*0.98*
Unconventional	50.4%	1.00	*0.95*	1.05	*0.98*	*0.98*	*0.99*	1.01	1.01
Total Public	70.4%	*0.97*	1.08	1.07	*0.99*	1.02	1.08	*0.99*	1.02

Table 17. Percent access – both total and relative – for each demographic group and green space type within East Tampa.

Traditional Green Space Access	% Population with Access	White	Black	Hispanic	Elderly	Youth	Single Parents	Owners	Renters
Large Parks	0%	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Regional Park	1.9%	*0.24*	*0.72*	*0.09*	*0.13*	*0.29*	*0.06*	*0.19*	*0.20*
Pocket Park	3.8%	1.32	*0.75*	2.05	*0.66*	1.03	*0.81*	*0.77*	1.30
Public Transit	62.9%	*0.89*	1.04	*0.95*	1.01	*0.99*	1.00	1.00	1.02
Walkable	62.9%	*0.89*	1.04	*0.95*	1.01	*0.99*	1.00	1.00	1.02
Neighborhood Park	95.6%	*0.99*	1.00	1.00	1.02	*0.99*	*0.98*	1.00	1.00
Water Access									
Natural Water	2.5%	1.42	*0.75*	2.03	*0.57*	1.02	*0.96*	*0.63*	1.52
Infrastructure	52.3%	*0.62*	1.16	*0.56*	1.01	1.01	1.02	1.06	*0.95*
Total Water	69.1%	*0.84*	1.07	*0.80*	*0.97*	*0.99*	1.00	1.05	*0.95*
Public Green Space Access									
Traditional	53.3%	*0.98*	1.00	1.09	1.00	*0.99*	*0.99*	*0.98*	1.05
Unconventional	56.7%	*0.63*	1.16	*0.53*	*0.99*	1.01	1.04	1.05	*0.95*
Total Public	80.3%	*0.88*	1.05	*0.88*	1.00	1.00	*0.99*	1.02	*0.98*

Despite existing disparities in available green space, East Tampa residents have greater access to the following types of green space relative to Tampa residents: 1) spaces accessible via alternative transportation (walking and public transit), 2) total public green space (including both unconventional and traditional), 3) water infrastructure, and 4) neighborhood parks (Table 15). This highlights the importance of equitably distributed green space, and not just total quantity, to improve overall accessibility. However, access to higher acreage green space, such as regional and large parks, as well as spaces with natural water features, were significantly lower for East Tampa residents.

In terms of travel distance, within Tampa the average nearest distance to green space was 337 m, with a maximum distance of 6,673 m. In comparison, East Tampa residents have an average and maximum distance of 257 m and 805 m respectively. As shown in Figure 12, the two types of green space nearest the majority of census block groups within both areas were those with water (blue grids) (53%) and neighborhood parks (green grids) (18.5%). This illustrates the prevalence of green spaces with water throughout the City of Tampa, as well as the predominance of neighborhood parks in the urban core, and regional parks (red grids) in the outer areas. Furthermore, because water infrastructures comprise the majority of these water features in the most heavily urbanized areas, there is considerable potential to reconnect residents with urban water while also improving green space access, particularly in locations that are currently lacking these social and environmental amenities.

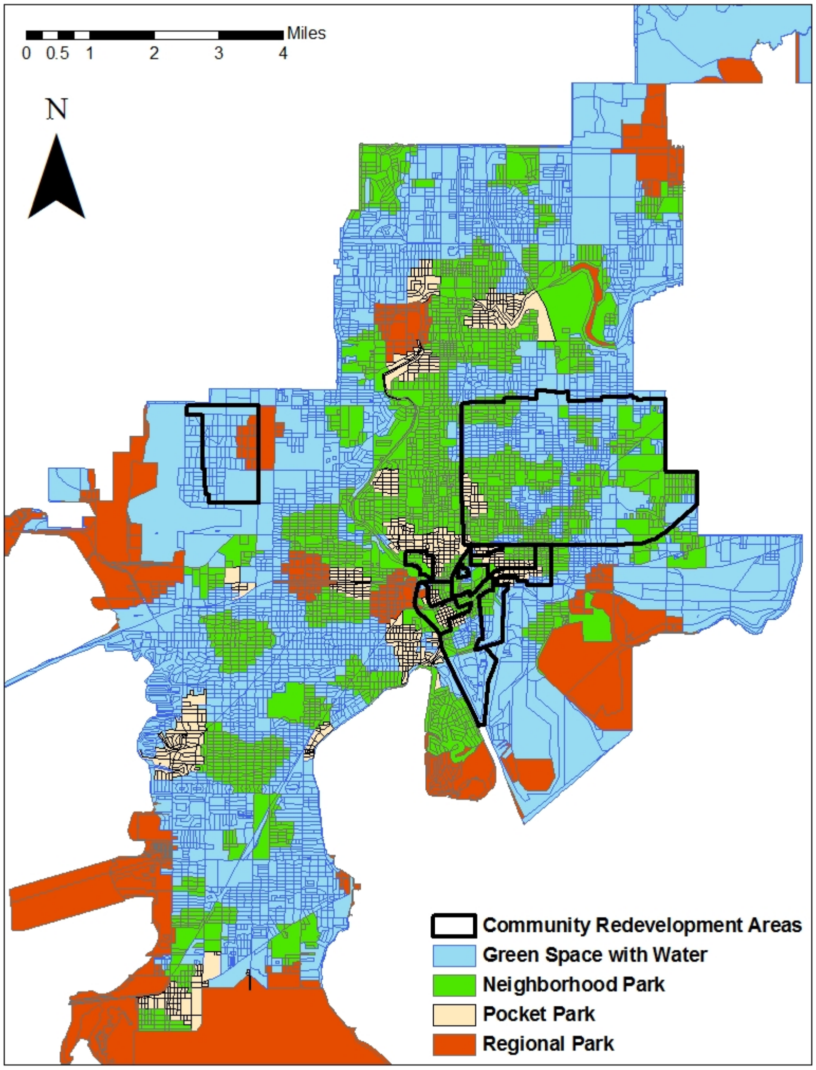

Figure 12. Nearest types of green space access for all census block groups within the City of Tampa.

4.3.2 Access by Socio-Demographic Group

As previously discussed, East Tampa residents have relatively greater access (compared to percentage of Tampa residents) to the three main categories of green space: 1) Traditional green space, 2) Green space with (total) water, and 3) Public green space (Tables 18 and 19). Although these broad categories mask individual green space access differences, their comparison provides useful insights. First, within East Tampa there appear to be fewer disparities in access among the eight socio-demographic groups compared with Tampa, which has more variation in the level of access (Fair to Excellent) than East Tampa, which is relatively lower (Marginal to Good), but more uniform (Table 20). These results also indicate that the highest need groups in Tampa have the greatest green space access, which is also true in East Tampa for the types of green space present. However, this analysis was not able to take into account inequities related to lower quality spaces or higher user congestion that may not be uniform within or between the study areas (Boone et al., 2009).

Table 18. Individual and overall level of access by each socio-demographic group and green space type for Tampa.

Traditional Green Space Access	**White**	**Black**	**Hispanic**	**Elderly**	**Youth**	**Single Parents**	**Owners**	**Renters**
Pocket Park	*marginal*	excellent	*marginal*	excellent	*fair*	good	*fair*	good
Large Parks	*fair*	excellent	excellent	*marginal*	excellent	excellent	*fair*	*fair*
Public Transit	*fair*	outstanding	excellent	good	good	excellent	*fair*	*fair*
Walkable	*fair*	good	good	good	good	good	good	*fair*
Regional Park	*fair*	good	excellent	good	good	good	*fair*	good
Neighborhood Park	*fair*	excellent	excellent	good	good	excellent	good	*fair*
Overall Access	***Fair***	**Excellent**	**Excellent**	**Good**	**Good**	**Excellent**	***Fair***	***Fair***
Water Access								
Natural Water	*fair*	outstanding	good	*marginal*	good	outstanding	*poor*	Excellent
Infrastructure	good	*fair*	good	*fair*	*fair*	good	good	good
Total Water	*fair*	good	good	*fair*	good	good	*fair*	good
Overall Access	***Fair***	**Good**	**Good**	***Fair***	**Good**	**Excellent**	***Fair***	**Good**
Public Green Space Access								
Traditional	*fair*	outstanding	good	good	good	excellent	good	*fair*
Unconventional	good	*fair*	good	*fair*	*fair*	*fair*	good	good
Total Public	fair	good	good	*fair*	good	good	*fair*	good
Overall Access	***Fair***	**Good**	**Good**	***Fair***	**Good**	**Good**	**Good**	**Good**

Table 19. Individual and overall level of access by each socio-demographic group and green space type for East Tampa.

Traditional Green Space Access	**White**	**Black**	**Hispanic**	**Elderly**	**Youth**	**Single Parents**	**Owners**	**Renters**
Large Parks	*poor*	*poor*	*poor*	*poor*	*poor*	*poor*	*poor*	*poor*
Regional Park	*poor*	*poor*	*poor*	*poor*	*poor*	*poor*	*poor*	*poor*
Pocket Park	outstanding	*poor*	outstanding	*poor*	good	*marginal*	*poor*	outstanding
Public Transit	*marginal*	good	*fair*	good	*fair*	good	good	good
Walkable	*marginal*	good	*fair*	good	*fair*	good	good	good
Neighborhood Park	*fair*	good	good	good	*fair*	*fair*	good	good
Overall Access	***Marginal***	***Marginal***	***Fair***	***Marginal***	***Marginal***	***Marginal***	***Marginal***	***Fair***
Water Access								
Natural Water	outstanding	*poor*	outstanding	*poor*	good	*fair*	*poor*	outstanding
Infrastructure	*poor*	excellent	*poor*	good	good	good	good	*fair*
Total Water	*marginal*	good	*marginal*	*Fair*	*fair*	good	good	*Fair*
Overall Access	***Fair***	***Fair***	***Fair***	***Marginal***	**Good**	**Good**	***Fair***	**Good**
Public Green Space Access								
Traditional	*fair*	good	good	good	*fair*	*fair*	*fair*	good
Unconventional	*poor*	excellent	*poor*	*fair*	good	good	good	*fair*
Total Public	*marginal*	good	*marginal*	good	good	*fair*	good	*fair*
Overall Access	***Marginal***	**Good**	***Marginal***	**Good**	**Good**	***Fair***	***Good***	***Fair***

Additionally, there were disparities in water access. In general, access to water features (including natural water) was above average for Hispanics, Youth, and Renters and below average for Elderly and Owners in both areas. Interestingly, access by Blacks differed significantly between East Tampa (Excellent water infrastructure access, Poor natural water access) and Tampa (Fair water infrastructure access, Outstanding natural water access) (Tables 18 and 19). Therefore, the enhancement of urban water infrastructures could reduce existing disparities in water access (i.e., low access to natural water, high access to "undesirable" engineered water infrastructure) for Blacks, Elderly, Youth, Single Parents, and Owners in East Tampa. In general, these same disparities do not exist within Tampa (with the exception for Elderly and Owners).

4.3.3 Development Scenarios

The three development scenarios analyzed the greening of grey infrastructure by enhancing social and environmental amenities to improve green space and water access. The first scenario (T1) analyzed the greening of all stormwater ponds within the City of Tampa and resulted in a significant improvement in walkable traditional green space access for Tampa (32.6% increase) and East Tampa (24.9% increase). While this scenario may have economic constraints, it illustrates the importance of designing and planning for integrated water and landscape management to achieve greater social and environmental benefits.

Scenario ET1, the revitalization of four large stormwater ponds in East Tampa, increased the amount of traditional and natural water green space from 21% to 28% and 0% to 7%, respectively. Although this increased the aggregate traditional green space access, it is still low compared to Tampa (3.6 versus 20.7 acres/1,000 residents). However, this scenario did provide residents with greater access to larger and more diverse green spaces that were previously lacking, particularly among groups with the lowest natural water access. Although Scenario ET2 (revitalization of three small ponds) did not provide significant increases in the amount of traditional green space or natural water features, it did result in noteworthy increases in access for both types of green space (Table 21).

Table 20. Overall level of access by each socio-demographic group and green space type for Tampa.

	% with Access[1]	White	Black	Hispanic	Elderly	Youth	Single Parents	Owners	Renters
Traditional Green Space Access									
Tampa	37.2%	Fair	Excellent	Excellent	Good	Good	Excellent	Fair	Fair
East Tampa	53.3%	Marginal	Marginal	Fair	Marginal	Marginal	Marginal	Marginal	Fair
Water Access									
Tampa	60.4%	Fair	Good	Good	Fair	Good	Excellent	Fair	Good
East Tampa	69.1%	Fair	Fair	Fair	Marginal	Good	Good	Fair	Good
Public Green Space Access									
Tampa	70.4%	Fair	Good	Good	Fair	Good	Good	Good	Good
East Tampa	80.3%	Marginal	Good	Marginal	Good	Good	Fair	Good	Fair

[1] Percent of the population with access (Table 15)

Table 21. Percent total increase in traditional green space and natural water access (over existing access) for the two East Tampa development scenarios.

Green Space Type	Scenario	Total Population	White	Black	Hispanic	Elderly	Youth	Single Parents	Owners	Renters
Traditional	ET1	15.4%	4.0%	20.0%	4.5%	16.1%	16.0%	16.2%	17.9%	11.7%
	ET2	8.9%	15.9%	6.5%	10.1%	6.9%	9.1%	9.4%	8.4%	10.9%
Natural Water	ET1	8.9%	1.9%	11.7%	1.8%	9.6%	9.9%	10.3%	10.4%	6.6%
	ET2	3.8%	8.2%	2.3%	4.9%	3.0%	3.6%	3.7%	4.2%	3.4%

These results illustrate two key points. First, improvements in access do not necessarily require large increases in the overall quantity of green space; they can be made through more equitable distribution of smaller green spaces. And second, water infrastructure can provide a way to reconnect inner city residents to the urban water cycle (while also improving green space access).

4.4 Discussion

Using GIS and 2000 census data, access to public green space and water features by eight socio-demographic groups within Tampa and the East Tampa Community Redevelopment Area was evaluated using a container approach, a service area analysis, and a minimum distance analysis. While the results of this research support previous studies that have evaluated environmental justice issues of unequal access to environmental amenities (e.g., urban green space) (Boone et al., 2009; Sister et al., 2007) and the integration of green and grey infrastructure to achieve more sustainable urban water management and improve urban quality of life (Ahern, 2007; McGuckin & Brown, 1995); this research also demonstrated the ability to improve green space access equality through the enhancement of existing engineered water infrastructures.

Within East Tampa, inequalities in green space availability and diversity were apparent, with no natural water features, and greater access to unconventional, smaller, and less desirable green spaces (i.e., cemeteries and stormwater ponds). While almost 75% of the green spaces with natural water features within the City of Tampa are accessible to residents via public transit, this potential access may not translate into use of these “destination” spaces. This is particularly true for East Tampa residents, especially those lacking mobility, since natural water features are located an average of six miles away. These environmental injustices of reduced access to desirable green spaces and natural water features provide important incentives to revitalize existing engineered water infrastructures. This also highlights the challenges of reconnecting residents to the urban watershed, which in many cases will only be possible through enhancing existing grey infrastructures. Similarly, there may also be greater challenges to removing barriers in public acceptance of water reuse in more inner city areas, such as East Tampa, compared to less urban areas within Tampa.

Despite having only half the acres per resident of total public green space as Tampa, East Tampa residents had greater overall access compared to Tampa residents (80.3% vs. 70.4%, respectively). Also, within East Tampa, residents were in closer proximity and twice as likely as Tampa residents to have green space accessible via alternative transportation. Nonetheless, the lack of non-motorized features along travel corridors, such as bike lanes, sidewalks, crosswalks, and landscaping, may negate the walkability or bikeability gained by closer proximity ("East Tampa Strategic Action Plan", 2009).

Within Tampa, groups identified from the literature with a greater need for nearby green space (i.e., minorities, youth, single parents, elderly, and renters) were found to have equal or greater than average access to most of the different types of green space, with the exception of Elderly (public green space and total water) and Renters (traditional green space). For East Tampa, however, overall access varied for these same groups, but was generally good for the types of green space found within East Tampa. On the surface, these results may demonstrate relatively equal access among these groups. Yet accessibility is not the same as usability and factors such as green space quality, diversity (in amenities), and size are important for encouraging greater use of these spaces. Therefore, issues of environmental injustice are still present within East Tampa due to existing disparities in the available green spaces.

Within Tampa, only a third of residents have access to green spaces via alternative transportation, yet almost half are within walking distance of urban water infrastructure. Although many of the existing 1,240 stormwater ponds within the City of Tampa have limited social benefits and environmental functions beyond flood control, the potential for improving nearby green space access was demonstrated in Scenario T1. While the redevelopment of these ponds may have economic constraints, this puts forth the challenge to urban planners and water managers to design and manage infrastructure with broader social, environmental, and economic functions that will allow the urban landscape to mimic natural processes and structures (Hill, 2007).

The East Tampa development scenarios further demonstrated the ability to significantly improve green space and water access by strategically revitalizing a limited number of unconventional spaces. While the revitalization of larger stormwater ponds (Scenario ET1) resulted in the greatest gains in traditional green space and natural water acreage, both scenarios improved overall access. The importance of equitably distributed green space was shown in Scenario ET2 through the enhancement of a relatively few, but strategically selected stormwater ponds, which resulted in significant improvements in accessibility compared to existing conditions. Additionally, as already shown by the redevelopment of two East Tampa stormwater ponds, integrating green and grey infrastructure provides new opportunities for reshaping how residents view and participate in urban water management, including broader goals of promoting watershed protection and water reuse ("East Tampa Strategic Action Plan", 2009).

Despite the lower green space diversity and availability within East Tampa, this analysis illustrated the ability to utilize existing urban water infrastructure as multi-functional spaces that can enhance natural amenities in urbanized communities. Ultimately, incorporating social and environmental amenities into water infrastructure will help improve green space access equality, reconnect residents with urban water cycle management, and ensure the long-term sustainability of urban landscapes. More holistic water management will be essential to maintain a high quality of life for residents by protecting and enhancing the resilience of natural systems within the urban landscape.

Chapter 5: Assessing the Impact of Development Scenarios of Urbanization, Population Growth, and Green Space Coverage on Urban Hydrology in a Developing World City

5.1 Introduction

Currently the world's population is migrating to urban centers, with more than 70% of the population estimated to live in cities by 2050 (UNFPA, 2007). Furthermore, developing world cities are expected to account for almost 95% of future population growth (UN-HABITAT, 2008). The rapid, and often unplanned, urbanization in developing countries has resulted in a lag in the provision of basic services such as piped water, sanitation, and waste collection in many of the fastest growing cities. Furthermore, much of this population growth is occurring in peri-urban areas, where access to these basic services has typically been very limited.

Urbanization alters watershed hydrology and affects the quantity and quality of surface water runoff and groundwater recharge due to land use changes, mainly through the loss of permeable surfaces, such as green spaces (Erickson et al., 2009). Green spaces are beneficial due to their ability to facilitate hydrological processes in areas where development has interfered with urban hydrology (i.e., the movement, distribution, and quality of water) (Niemczynowicz, 1999). These permeable spaces provide important ecosystem services such as filtering water pollutants, reducing stormwater runoff and flooding, and enhancing groundwater recharge (US EPA, 2001). Therefore, as the amount of permeable surfaces decrease, a shift occurs in water distribution from partially subsurface flow to almost all surface runoff (Shuster et al., 2005).

Changes in land use, particularly the replacement of open space and vegetation by less pervious materials (i.e., buildings, roads, parking lots), causes urban areas to become warmer than surrounding areas because these impervious materials absorb heat and release it more slowly (Figure 13). Solar reflectance (i.e., albedo), is influenced by the color of materials, with darker colors, like asphalt and tar roofs, reflecting less and absorbing more solar energy, which warms the air above them (EPA, 2008). Increases in human-modified surfaces also increases energy and moisture fluxes causing a larger partitioning of solar inputs into sensible heat (surface and air temperature) rather than latent heat (actual evaporation) (Stohlgren et al., 1998). Thus urban heat islands are formed due to the different cooling rates that occur between urban and non-urban landscapes (EPA, 2008).

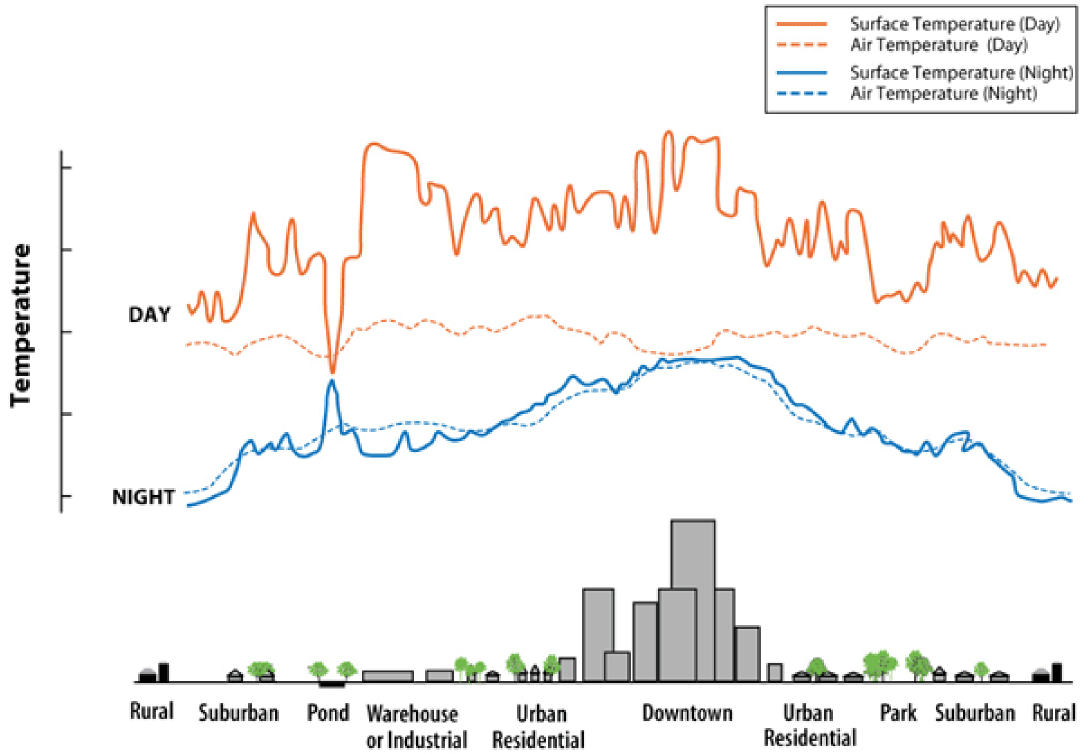

Figure 13. Schematic of the urban heat island effect, highlighting the variation of surface and atmospheric temperatures (EPA, 2008).

Future impacts of land use change on urban hydrology are important to estimate due to the increasing demands being placed on finite resources. However, data availability in developing countries, particularly for hydrologic data, is a frequent problem (Fry et al., 2010; US Army Corps of Engineers, 2004). As a result, it is often difficult to use many hydrologic models in a developing world context due to their complexity and extensive data input. Often an initial assessment of the hydrological impacts of urbanization, using available input data in a simplified model, such as a water balance, can provide preliminary measures of the relative impacts of the land use change (Bhaduri et al., 2000). Furthermore, Martinez et al. (2010) concluded that the *abcd* model was adequate in representing water balance dynamics in humid catchments.

As shown in Table 22, water balance models are widely used to estimate a variety of hydrologic conditions in both gauged and ungauged catchments. Due to difficulties in measuring runoff and groundwater recharge, many of these studies have applied water balance models to quantify current values or simulate future changes. Although some of these studies examined impacts of spatial and/or temporal changes on hydrologic processes, the majority were conducted in industrialized nations.

Table 22. Previous studies utilizing water balance models including the model application, catchment description, and location (italics indicates developing world).

Study	Water Balance Model	Application	Catchment	Location
Thomas (1981)	"abcd" model	Improve National Water Assessment	Gauged	Georgia, USA
Alley (1984)	"abcd" model	Estimate runoff from precipitation and potential evapotranspiration	Gauged	New Jersey, USA
Grimmond et al. (1986)	Urban water balance	Evaluate components o water balance in a suburban environment	Gauged urban water systems	British Columbia, Canada
Vandewiele et al. (1991)	Lumped system water balance	Model rainfall-runoff process	Ungauged	Northern Belgium
Vandewiele et al. (1992)	Variety of models	Fill in missing runoff data; apply to ungauged catchments; apply smaller time steps	Gauged	Belgium, *China*, and *Burma*
Finch (1998)	Daily water balance model	Estimate groundwater recharge and sensitivity to land surface parameters	Conceptual (based on meteorological data)	UK
Xu (1999)	MWB-6 model	Simulate streamflow using a conceptual model	Unguaged	Central Sweden
Fernandez et al. (2000)	"abcd" model	Regionalization of a watershed model	Ungauged	Southeastern USA
Vorosmarty et al. (2000)	Water Balance Model (WBM)	Combine climate model outputs, water budgets, and socioeconomic information to access global water stress	Digitized river networks	Global
Sankarasubramanian et al. (2002)	"abcd" model	Develop physical models that do not require calibration or streamflow data	Gauged	Continental USA
Mitchell et al. (2003)	Continuous daily model	Evaluate impact of urbanization on hydrological processes	Gauged	Canberra, Australia
Dripps et al. (2007)	Soil-water balance (SWB)	Estimate temporal and spatial distribution of groundwater recharge	Gauged	Wisconsin, USA
Erickson & Stefan (2009)	Water budget	Quantify changes in natural groundwater recharge due to urbanization	Ungauged	Minnesota, USA
Fry et al. (2010)	Daily water balance model	Examine sustainability of groundwater resource from changes in land use and climate	Ungauged	*Alto Beni, Bolivia*

Overall, the goal of this research is to examine the impact of urbanization, population growth, and loss of green space on urban hydrology in Santa Cruz, Bolivia. A regional water balance approach is developed to evaluate scenarios that reflect historical (1990), current (2010), and future (2050) development conditions. Model parameters and input variables are adjusted to simulate spatial alterations (i.e., land use changes due to urbanization and population expansion) and temporal changes (i.e., climate change) to analyze how these stressors impact the water balance over time. Three scenarios were developed for both spatial alterations (based on assumptions of coordinated, moderate, and rapid growth scenarios) and temporal changes (based on climate emission scenarios A1B, A2, and B1). The water balance model was run using five combinations of these scenarios – all spatial scenarios were run using climate projections from emission scenario A2 and all temporal changes were run using parameter values based on the moderate growth scenario.

Due to the importance of the aquifer system in Santa Cruz, changes in groundwater recharge will be examined in order to evaluate water quality impacts in the shallow and deep aquifers. In particular, potential water quality issues will be explored in terms of basic service coverage (e.g., sanitation, stormwater drainage, road infrastructure) and the societal implications for Santa Cruz residents.

5.2 Background

5.2.1 Urban Hydrology

The hydrology of a watershed, specifically groundwater recharge, is dependent on factors such as climate (precipitation intensity and duration), soil properties, and aquifer depth (Dunn et al., 1995; Erickson & Stefan, 2009). Impervious coverage exceeding 10 to 30% has been found to drastically impact surface runoff volumes and cause significant degradation of downstream ecosystems (Brun et al., 2000; De Silva et al., 2009). However, there is no linear relationship between land use change and changes in runoff (Bhaduri et al., 2000). As shown in Figure 14, increasing impervious surfaces by 75 to 100% can increase surface water runoff from 10 to 55%, decrease evapotranspiration from 40 to 30%, and decrease direct groundwater recharge from 25 to 5% (FISRWG, 10/1998). Furthermore, stormwater runoff flowing over impervious surfaces becomes contaminated with urban runoff and pollutants that are typically discharged untreated into receiving waterways.

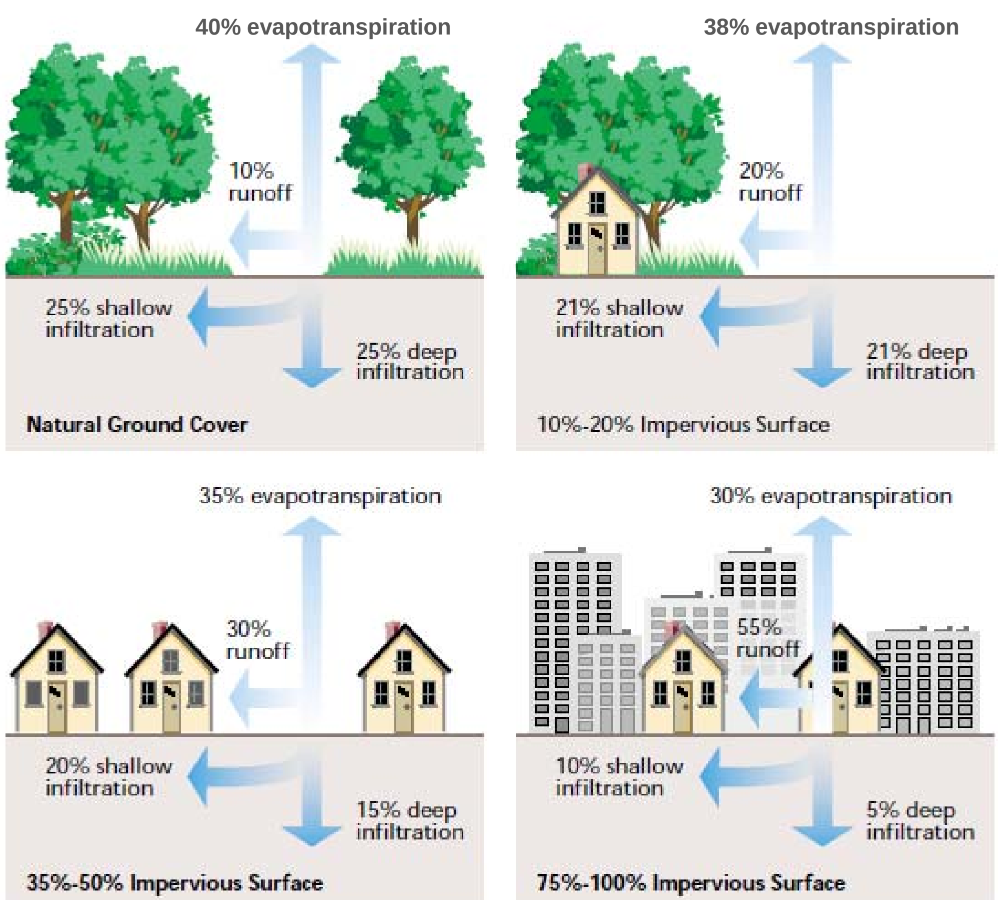

Figure 14. Impacts of increased impervious coverage on the hydrologic cycle (FISRWG, 10/1998).

The addition of stormwater drainage networks has been found to compound the effect of impermeable surfaces such as roads, buildings, and parking lots in reducing the infiltration of excess precipitation – the source for natural (direct) groundwater recharge (Shuster et al., 2005). These drainage systems also cause a decrease in evapotranspiration, which increases both the quantity and the velocity of surface water runoff. This differs from natural drainage, which allows for temporary storage that is then gradually released to surface and subsurface flows. Furthermore, stormwater recharge may be a source of dilution of wastewater discharged to subsurface environments in unsewered cities; thus, extensive drainage networks will greatly reduce this generally beneficial recharge source (BGS et al., 1997).

Despite the large quantities of impermeable surfaces in urban areas, urbanization has been found to increase overall recharge – but not direct recharge (Lerner, 1990, 2002). This is attributed to the fact that urbanization replaces and modifies recharge pathways while also creating new discharge sources (BGS et al., 1995). Water infrastructure can generate large quantities of recharge through leaks in water distribution and sewer collection systems, which have been reported as low as 10% and as high as 50% (Lerner, 1990). In-situ sanitation as well as over-irrigation of public and private green spaces is also a significant source of urban groundwater recharge. Cities that have shallow unconfined aquifers can be significantly impacted by water and wastewater systems through leakage and/or seepage, which become major components in the hydrological cycle of urban watersheds (BGS & SAGUAPAC, 1995).

Land use changes not only alter the water balance, but they also alter processes that control water quality; thus, "a land-management decision is a water-resource decision" (Peters et al., 1999). This highlights the impact of the various "cascading" effects of urbanization activities on water quality and quantity that alter hydrologic pathways. In many developing countries, existing regulations and laws aimed at the protection of water resources may only exist on paper with little enforcement due to a lack of will and/or a lack of financial resources for monitoring and enforcement (Lee, 1999). Furthermore, developing world cities often struggle with a weak planning structures, governance over land and resource use, and limited collaboration between government sectors.

Although rapid urbanization may drastically alter hydrological processes and degrade natural resources within a relatively short period of time, these negative impacts of land use change and the resulting increases in pollutant loading tend to be gradual or delayed (Lee, 1999). This typically does not cause the same response that a disease outbreak or a devastating flood might. Moreover, although these disasters may be a delayed effect of urbanization impacts, the root problem (i.e., land use change) is typically not addressed as part of the response. Similarly, the lack of resources available in many developing countries often dictates short-term solutions to problems that need sustained attention and investment to produce long-term benefits. While these investments (e.g., watershed and aquifer recharge area protection, environmental education) may produce long-term social, environmental, and economic benefits such as clean water and reduced health risks, it can be difficult for developing countries to justify, particularly when they do not lead to short-term benefits such as revenue improvements or increased water or sanitation coverage (Lee, 1999).

5.2.2 Existing Conditions in Santa Cruz, Bolivia

5.2.2.1 Urbanization, Population Growth, and Land Use Changes

Santa Cruz has been one of the fastest growing cities in Latin American (Morris et al., 1994), with much of this growth concentrated in the low-income peripheral districts. In the early 1950s, Santa Cruz occupied an area of less than 10 square kilometers; however, the city has sustained population growth rates greater than five percent, so that by 2010, it had reached approximately 380 square kilometers. Figure 15 illustrates the annual population and urbanized land area growth rates for various time periods in Santa Cruz (1956-2010). Initially population growth outpaced urbanization (1956-1964), however, due to political policies, a completed national highway, and the view of the eastern lowlands as the "new frontier", the rate of urbanization rapidly increased between the 1960s and the early 1980s (Kirshner, 2009). The Latin American debt crisis in the 1980s may have contributed to a reduction in the amount of new urbanized land area, although population growth was maintained above five percent. By the 1990s the department of Santa Cruz had become a regional leader in the national economy and migration by lower- and middle-class western highlanders continued as a result of these economic opportunities (Kirshner, 2009). Although the rate of population growth has gradually slowed – between 2004 and 2010 it dropped below four percent for the first time in the history of the city – low-density peri-urban settlements continue to expand the amount of urbanized land.

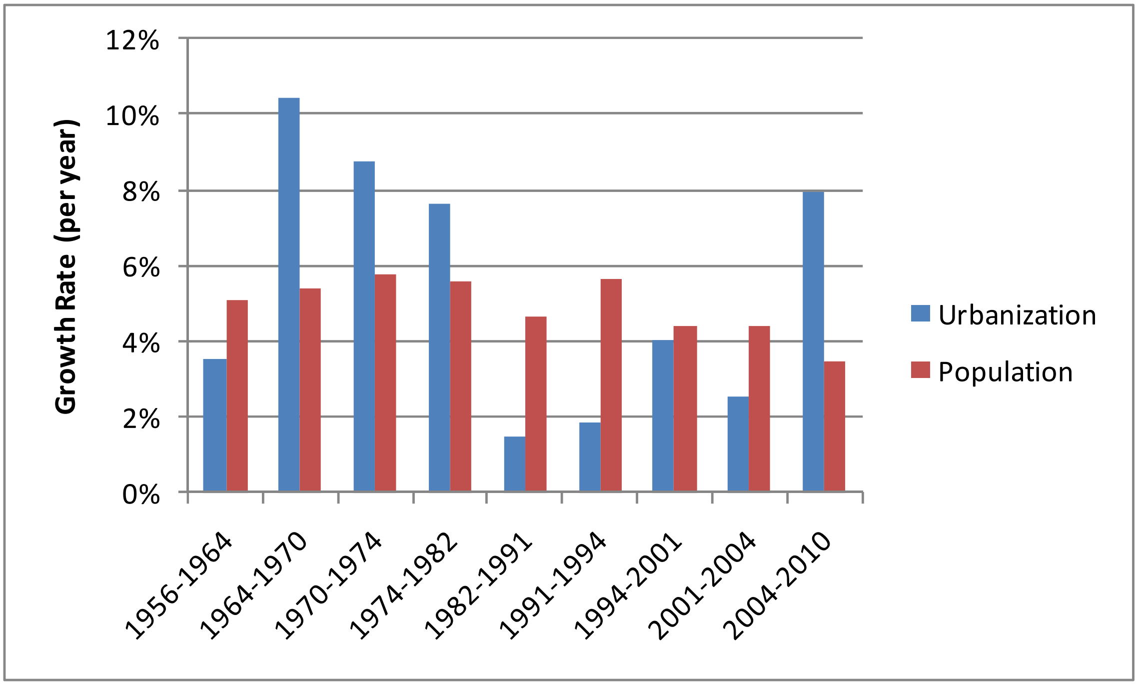

Figure 15. Rate of population growth and urbanization (percent per year) in Santa Cruz from 1956 through 2010.

Due to this prolonged rapid growth, Santa Cruz became the largest city in Bolivia with a population of more than 1.6 million inhabitants in 2010. Unfortunately, this unplanned growth has been sprawled, low-density development, where basic services have lagged behind urban expansion. As a result, the population density has continued to decrease over time – from 10,400 people/km^2 in the 1960s to 4,200 people/km^2 in 2010. Table 23 compares the population density of Santa Cruz with other global cities that have similar built areas.

Table 23. Population densities of cities with built areas of similar size as Santa Cruz, based on 2010 estimates (The City Mayors Foundation, 2007).

City	**Population (millions)**	**Area (km^2)**	**Density ($people/km^2$)**
Taipei, Taiwan	5.7	376	15,200
Recife, Brazil	3.0	376	8,050
Dalian, China	2.8	389	7,100
Santa Cruz, Bolivia	*1.6*	*384*	*4,200*
Leeds/Bradford, UK	1.5	370	4,050
Glasgow, UK	1.2	368	3,250
Dublin, Ireland	1.1	365	2,950
Porto, Portugal	1.0	389	2,650

As shown in Figure 16, the greatest growth has occurred in the peripheral area of the city, which has caused the city limits to swell outwards. This concentration of urban population and poverty in the peripheral area is common in many cities in Latin America, where 70% of the population resides (Ducrot et al., 2004). This can be attributed to issues of land access for low-income groups. Often, the only means is through illegal settlement in peripheral areas where laws are lax or nonexistent and land speculation is prevalent. Furthermore, the land occupied is often of lower-value and vulnerable to floods, landslides or other hazards due to the unsuitable conditions on steep slopes, within flood plains, etc. These illegal settlements also lack the most basic infrastructure and services such as waste removal, sanitation, potable water, and electricity. And although the peri-urban interface can often provide important hydrological functions due to greater opportunities for groundwater recharge and storage for stormwater runoff due to fewer impervious surfaces, these settlements often pose major threats to existing ecosystems and water resources through the creation of illegal dumps and inadequate wastewater disposal (Ducrot et al., 2004). In fact, in many of the outer districts brownfield sites have been created as a result of illegal dumping activities (Wright Wendel & Mihelcic, 2009).

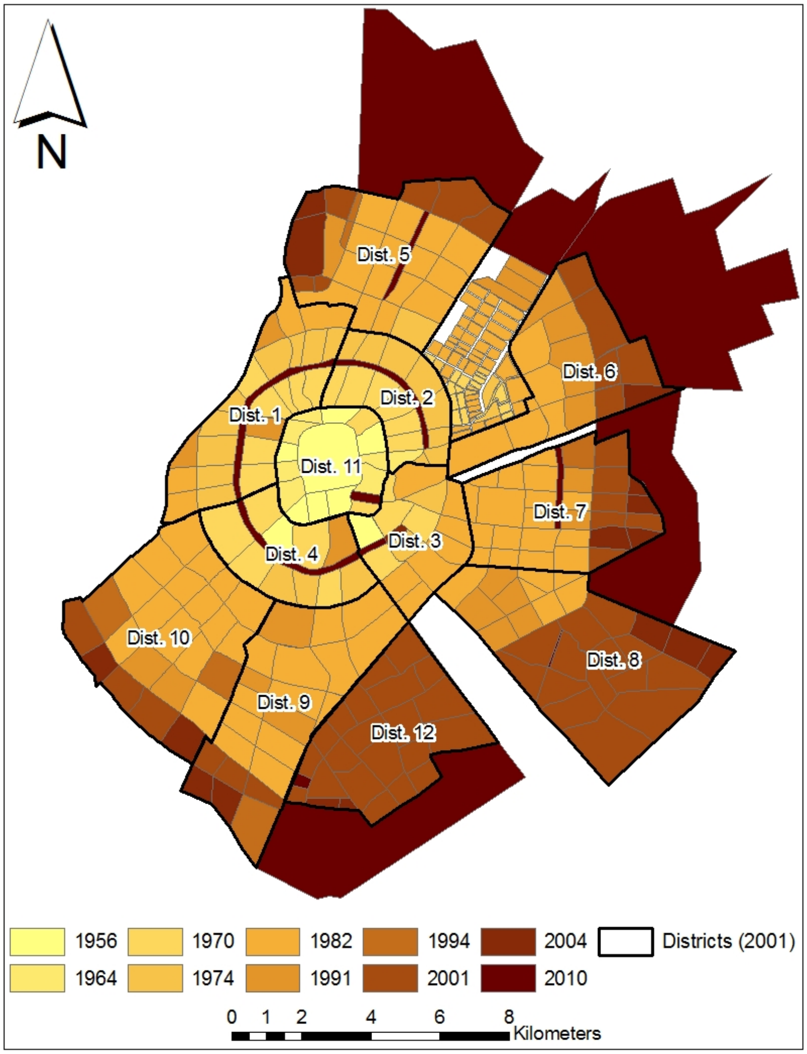

Figure 16. Urban expansion in Santa Cruz (Bolivia) from 1956 through 2010.

The rapid population growth and urban expansion in Santa Cruz has also caused a significant loss or degradation of traditional green space (i.e., parks) and open space (Figure 17) that has further been exacerbated by improper waste management. This unchecked growth along with the loss and/or degradation of green space has resulted in increased groundwater pollution and stormwater drainage problems as well as reduced access to public spaces. Unfortunately, the degradation of green space has not just been experienced within the city limits. The Piraí River, forming the western edge of the city, and the Lomas de Arena National Park, located just beyond the outer limits of District 12, have been impacted by urban expansion, altered hydrology, and environmental degradation (Museo de Historia Natural "Noel Kempff Mercado" et al., 2007).

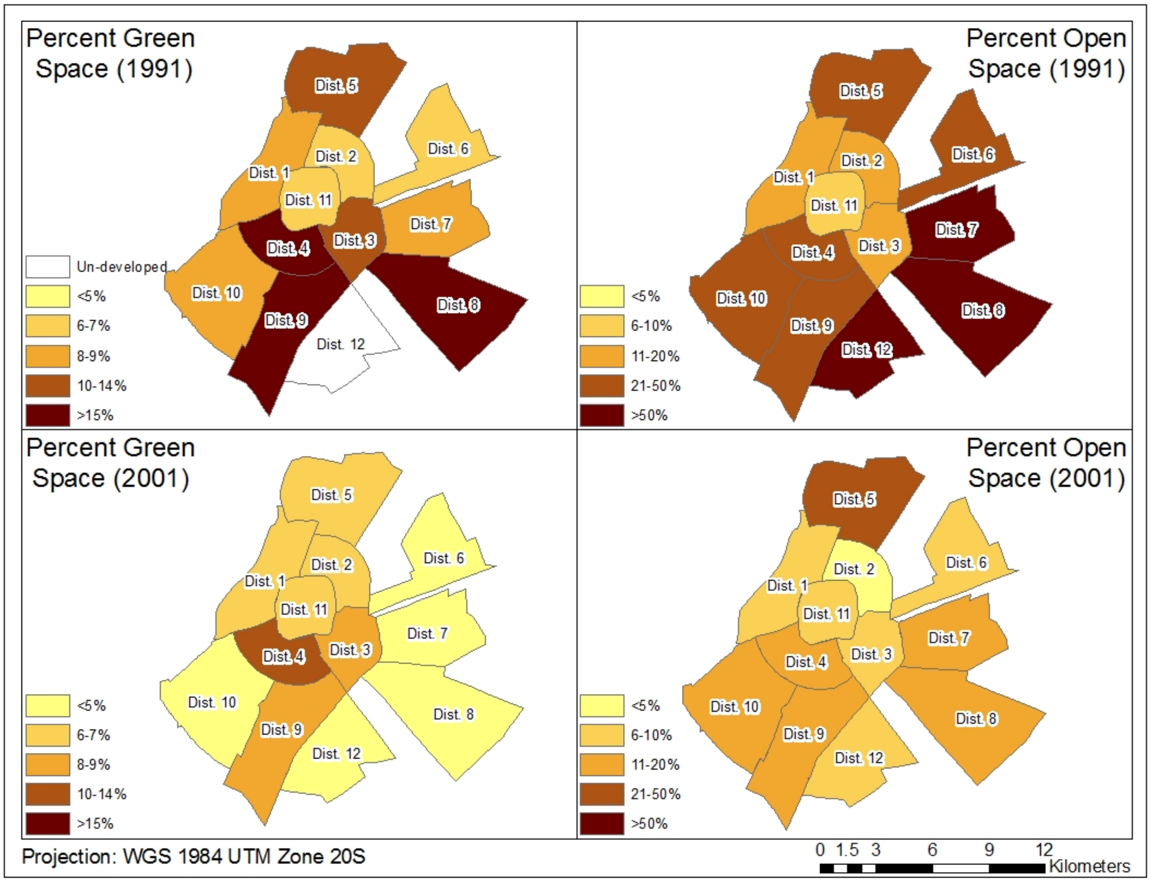

Figure 17. Santa Cruz (Bolivia) green space (park) and open space coverage in 1991 and 2001.

5.2.2.2 Provision of Basic Services and Infrastructure

Like many cities in the developing world, Santa Cruz is entirely dependent on groundwater for its water supply (BGS & SAGUAPAC, 1995; A. R. Lawrence et al., 2000). Santa Cruz is unique in that water services are provided by cooperatives, which have been highly dynamic and adaptable to the rapidly growing population (Carruthers, 2006). For example, the water distribution system was expanded from 10,800 connections (16,000 m^3 of water per day) in 1971 to 57,250 connections (68,850 m^3/day) in 1990 (BGS & SAGUAPAC, 1995). The approximate expansion of water services between 1990 and 2007 is shown in Figure 18. In addition to public wells (maintained by the water cooperatives), there are also many private wells for water consumptive industries (e.g., beverage bottling, oil refineries, paper and sugar mills), small businesses, and individual residences (primarily higher-income inner suburbs or outer suburbs not supplied by the water cooperatives). While the public wells draw from deeper levels of the aquifer, the majority of private wells draw from depths of less than 90 m, with some of the lower-income communities in the outer districts drawing from the top 20 m. This has important water quality implications that will be discussed in the next section.

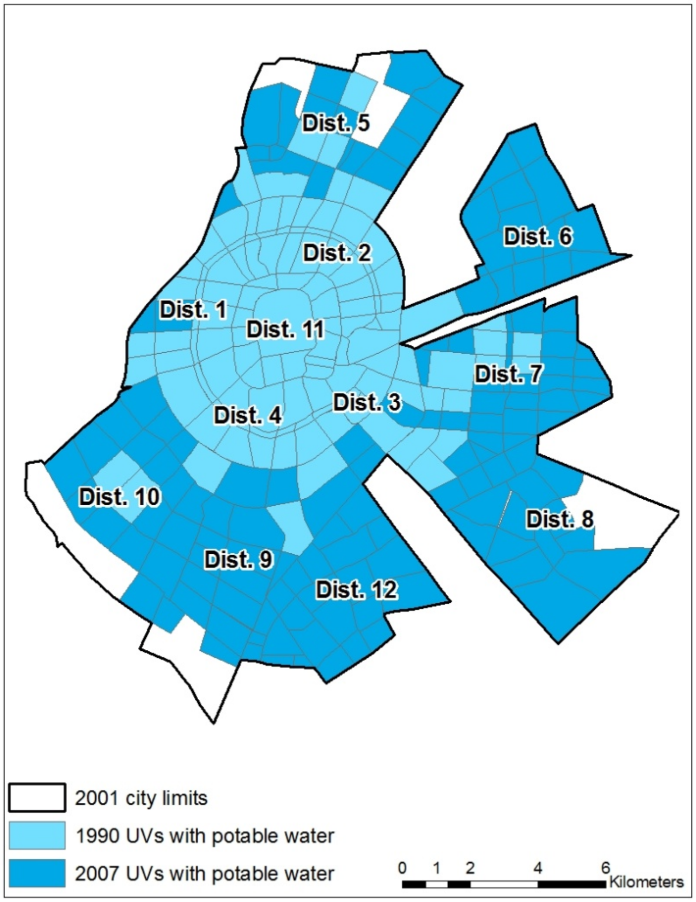

Figure 18. Potable water coverage by *UV* (*Unidad Vecinal* or neighborhood unit) in Santa Cruz (Bolivia) from 1990 to 2007.

Despite having an extensive water distribution system, the sanitation system has been significantly less developed (Figure 19). In 1990, it was estimated that only 15 to 20% of the city's wastewater was removed for treatment in the stabilization lagoons (BGS & SAGUAPAC, 1995). After 1990, there was a major initiative to extend the sewerage coverage out to the 4^{th} Ring and by 1994 almost 30% of the city had sewer coverage (BGS & SAGUAPAC, 1997). Yet, rapid population growth in the outer districts outpaced coverage increases so that by 2001, only 26% of households were connected to sanitary sewers. As shown in Figure 20, there is still a large percentage of the city relying on in-situ treatment systems, such as septic tanks, pit latrines, and soakaways. Due to the large quantity of wastewater disposed via in-situ systems, it has been estimated that this form of recharge is as great as precipitation and river leakage (BGS & SAGUAPAC, 1995). Currently, there is additional expansion of sewered sanitation planned in Santa Cruz, with the largest increase occurring from the 4th Ring out to the 6th Ring.

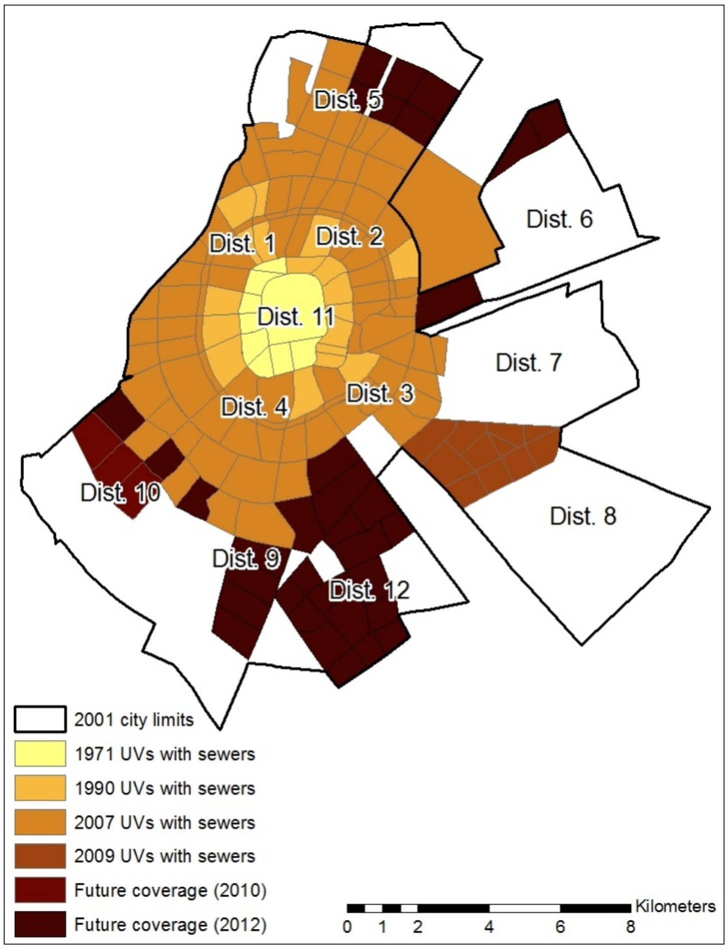

Figure 19. Sanitary sewer coverage by UV (*Unidad Vecinal* or neighborhood unit) in Santa Cruz (Bolivia) from 1971 through projected 2012 coverage.

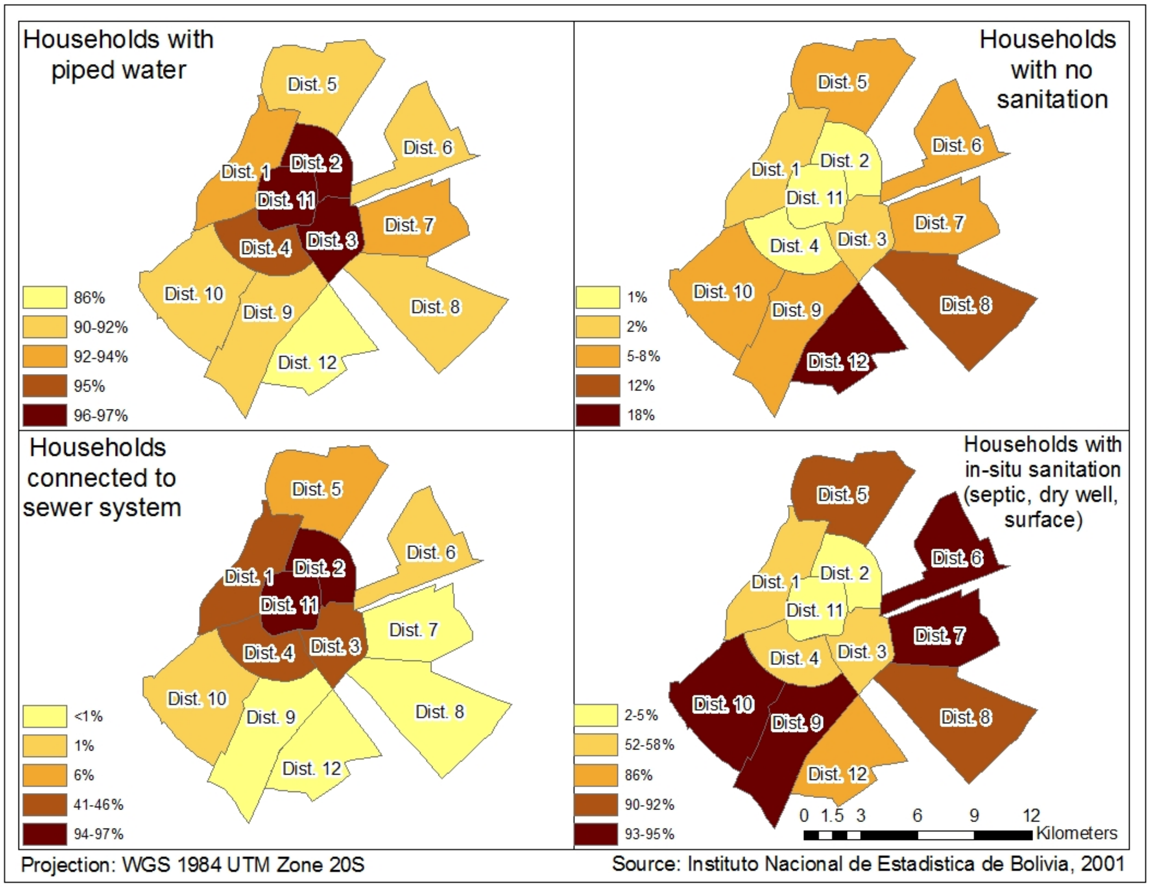

Figure 20. Sanitation and potable coverage in the city of Santa Cruz (2001).

The current stormwater drainage network is made up of earthen and concrete-lined canals that are controlled by a north-south ridge that divides the city. The northwest area of the city has more clay, a high water table, and more problems with flooding. Therefore, this area has the longest canal system. The construction of concrete-lined canals was a priority for the municipality between 1988 and 1995 (BGS & SAGUAPAC, 1997) and again in the last decade. Prior to the lined canals, earthen canals were used to alleviate the flooding problems throughout the city; however, due to irregular maintenance, these canals, which are less expensive to construct and provide groundwater recharge, became filled in with sand and garbage and required major work every several years. Therefore, it is now mandated that new canal construction consist of concrete-lined canals. This has long-term implications for water quality due to the loss of the relatively high quality stormwater runoff that can provide dilution to in-situ sanitation recharge entering the shallow aquifer (BGS & SAGUAPAC, 1995).

5.2.2.3 Aquifer System

Beneath the city of Santa Cruz there are alluvial fan deposits of moderate-high permeability. As illustrated in Figure 21, sand, clay, and sandy clay are present in lenses, which permits groundwater to move both vertically and horizontally through the aquifer (BGS & SAGUAPAC, 1995). Although vertical leakage may be impeded locally, the sediments beneath Santa Cruz can be considered a single aquifer with good hydraulic connection between shallow and deep layers. However, it can be divided into a semi-confined deeper aquifer (below 45 m) and an upper less permeable shallow aquifer.

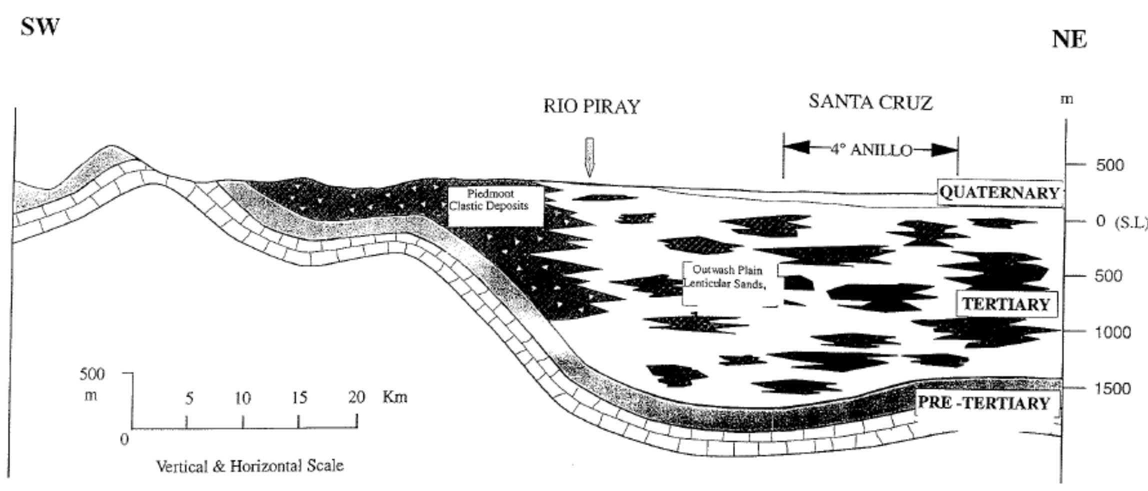

Figure 21. Cross-section illustration of the Santa Cruz aquifer system showing the individual beds of sand, clay, and sandy clay beneath the city (BGS & SAGUAPAC, 1995).

The upper 25 m of the aquifer in the southwestern portion of the city is dominated by gravels and sands. In the southern half of the city there is a scattered covering of clayey silt over these sediments, which is often removed for brick-making or punctured by construction activities. In areas where the clayey silt is absent, rapid infiltration occurs. However, in the northeastern and northern portions of the city there are more clay-dominant strata, with thicker beds that are likely to impede, but not prevent, the vertical and horizontal flow of recharge (BGS & SAGUAPAC, 1995).

Land use changes that occurred during the urbanization process in Santa Cruz through the early 1990s may have actually improved recharge of rainfall due to changes in vegetation, low levels of impermeable surfaces near highly permeable sandy subsoils, and a relatively undeveloped stormwater drainage network (BGS & SAGUAPAC, 1995). Rapid infiltration in these permeable soils near impermeable surfaces would have also reduced evaporation, thus increasing recharge relative to pre-urban conditions.

Due to the relatively flat terrain of Santa Cruz, there is a small (9 m) north-south ridge that creates a surface water divide between the Piraí River and the Grande River systems(Figure 22) (BGS & SAGUAPAC, 1997). The groundwater level fluctuates from very shallow in the northwest, where the ground surface is almost level with the Piraí River, to 15 m beneath the dividing ridge that crosses the center of the city.

Figure 22. Location of the Piraí and the Grande Rivers relative to the city of Santa Cruz (Bolivia), including the upstream location of the Angostura station on the Piraí River. The path of highway 7 within the city's boundaries indicates the relative location of the north-south dividing ridge between the two rivers.

Since groundwater abstraction began in the 1970s it has largely been uncontrolled and increasingly less sustainable, so that in the next few decades, it is estimated that the city will exceed the sustained yield of the aquifer system (GMSC, 2007). Up until the early 1990s, the regional groundwater flow in the deep aquifer followed a general southwest to northeast flow pattern. However, by 1994, the cumulative amount of pumped water was equal to the volume stored within the first 50 m of the aquifer (Morris et al., 1994) and by 1995, the regional flow had been impacted by pumping from the deep aquifer so that the regional trend was no longer identifiable (BGS & SAGUAPAC, 1997).

Prior to urbanization and the accompanying groundwater extraction, downward leakage did not occur. Although the majority of the water is pumped from the deep aquifer, which causes this vertical downward leakage, data through the 1990s indicated that the water table in the shallow aquifer had remained relatively flat (BGS & SAGUAPAC, 1995). In fact, it is estimated that 70% of the pumped groundwater is recycled back to the upper aquifer via urban-derived recharge (i.e., water distribution leakage, in-situ wastewater disposal, and irrigation). The relatively stable shallow water table was attributed to this increased urban-derived recharge, which exceeded the downward leakage, as well as reduced evapotranspiration due to increased impervious surfaces. Overall, it has been estimated that the shallow aquifer recharge may have doubled from pre-urban levels. This is particularly true in the southwest portion of the city that is characterized by moderate population density, an aging water distribution system, close proximity to a major well field, and predominantly sandy soil (BGS & SAGUAPAC, 1997). It is assumed that extra recharge is dispersed by downward leakage to the deeper aquifer layers.

5.2.2.4 Water Quality

In the past several decades, the modified groundwater flow system has resulted in overall declining groundwater levels (Ibañez, 2010). The lowered water levels and the now vertical groundwater flow paths have reduced the ability of natural recharge to dilute the poorer quality urban-derived recharge. In fact, the large contribution of wastewater to the aquifer has caused a deterioration of groundwater quality in the upper aquifer, with the presence of fecal coliforms found in many of the shallow wells (BGS & SAGUAPAC, 1995).

Fortunately, semi-confined aquifers are less susceptible to contamination from urbanization activities; although, heavy abstraction threatens the deeper aquifer by producing greater vertical gradients, which are drawing the urban-derived recharge further down (A. R. Lawrence et al., 2000). The rate of the downward migration of this urban-derived recharge was estimated around 3 m per year, which means that water from the surface would take 20 to 30 years to reach the intermediate aquifer layers (45-90 m), and more than 30 years to reach the deeper aquifer layers (Morris et al., 1994). Therefore, by the 1990s researchers were beginning to see urban-derived recharge from the 1960s in the upper layers of the deeper aquifer (BGS & SAGUAPAC, 1997). Thus indicating that downward leakage from urban recharge constitutes the majority of the local recharge to the deeper aquifers (Morris et al., 1994). Yet, the increasing amount of pumping by private wells (above 90 m) is providing some protection for the deeper aquifer by intercepting, abstracting, and recycling part of the contaminated urban-derived recharge (BGS & SAGUAPAC, 1997).

Due to the differing sediments, the city's southern half of the deep aquifer is more vulnerable to contamination relative to the northern half. As a result, the British Geological Survey (1995) made several recommendations that would help reduce the threat of further contaminating the aquifer. These included assigning a higher priority to improve sanitation in the south and southeast districts of the city while limiting development that could further exacerbate the vulnerability of the aquifer in those areas (e.g., landfills, industry, low-income housing lacking sanitation, waste collection, etc).

Unfortunately, the southern portion of the city has been urbanizing very rapidly in the last few decades, with grow rates between five and 11% between 1992 and 2001, including large influxes of immigrants (Salmón, 2005). Yet that growth has not been accompanied by improved sanitation or other basic services. In fact, the south and southeast areas of the city have the highest percentage of homes without sanitation (Figure 20) and the highest percentage of residents living below the poverty line (see Figure 7 in section 3.2). Many of these communities also lack access to other basic services such as waste disposal, which often leads to increases in illegal dumping, and may further decrease recharge quality into the aquifer in these areas. Peters et al. (1999) note that in many locations a primary cause of water scarcity is the result of water quality degradation, which impacts the availability of potable water. Hence, in the long term, the challenge of providing clean water may exceed that of supplying adequate water quantities in Santa Cruz (Vorosmarty et al., 2000).

However, naturally occurring attenuation processes in the unsaturated zone help to remove many of the contaminants in wastewater as it moves through the soil. Santa Cruz has a moderately thick (more than 10 m) unsaturated zone in some areas of the city, which assists with pollutant removal (Morris et al., 1994). Yet, when pollutants enter the subsurface directly, through in-situ systems, the wastewater by-passes the soil zone. Because these systems remove wastes quickly and have a greater hydraulic loading than pollutants entering the soil zone, there is a shorter residence time and decreased ability for natural attenuation processes to occur (Morris et al., 1994).

As previously discussed, prior to the 1990s, there was very little sanitary sewer coverage in Santa Cruz, which resulted in significant concentrations of domestic and industrial wastes being discharged to the subsurface that contained contaminants such as nitrogen, chloride, and fecal pathogens (Morris et al., 1994). In the long term, it is common for aquifers underneath unsewered cities to have elevated nitrate and chloride concentrations. This is a result of the long travel times, which allows only mobile or persistent compounds to infiltrate the deeper aquifer layers.

Chloride, which is found in wastewater, is highly mobile, is not readily absorbed, complexed, or exchanged during transport; and therefore can be used as an indicator of water quality and residence time (BGS & SAGUAPAC, 1997). Although nitrogen is readily leached, the primary form of nitrogen after land application is nitrate. As shown in Table 24, the intermediate aquifer (45-90m) has higher concentrations of pollutants; however, the concentrations are less than in the shallow aquifer. In the 1990s, the deeper aquifer (>90 m) had excellent water quality and was considered similar to the shallow aquifer up-gradient of the city, representing the natural unpolluted background (Morris et al., 1994).

Table 24. Indicators of groundwater pollution for the complex semi-confined aquifer system of the city of Santa Cruz, Bolivia (Morris et al., 1994).

	Shallow aquifer (0 - 45 m)		**Deep aquifer (45 - 200 m)**		
Contaminants	**Background (mg/L)**	**Urban Range (mg/L)**	**Background (mg/L)**	**Urban Range (mg/L)**	**Source**
Nitrate	<10	10 - 40	<5	5 - 25	Unsewered sanitation
Chloride	<40	40 ≥ 120	<10	10 ≥ 50	Unsewered sanitation
Bicarbonate	<300	300 - 600	<250	250 - 350	Degradation of organic wastes
Iron	<0.1	0.1 1.4	<0.1	0.1 - 6.0	Mobilization of reduced iron, Fe^{2+}
Sulfate	<30	30 - 90	<10	10 - 30	Detergents; road runoff

Note: Units are – nitrate as mg N/L; bicarbonate as mg HCO_3/L; and sulfate as mg SO_4/L.

Figures 23-25 illustrate the changes in chloride, nitrate, and sulfate concentrations in both the shallow and deeper aquifer wells over time (1976-2009). The select SAGUAPAC deep aquifer wells are located in areas that were originally undeveloped, but are now closer to the more densely developed central area of the city. Based on these figures the higher contamination of the shallow aquifer can be seen, along with increasing concentrations in the older SAGUAPAC wells (i.e., Select SAG wells). The lower concentrations in the deep aquifer SAGUAPAC wells mask regional differences in water quality. These values are an average of all SAGUAPAC wells, which include newer and deeper wells that have been drilled in less developed areas.

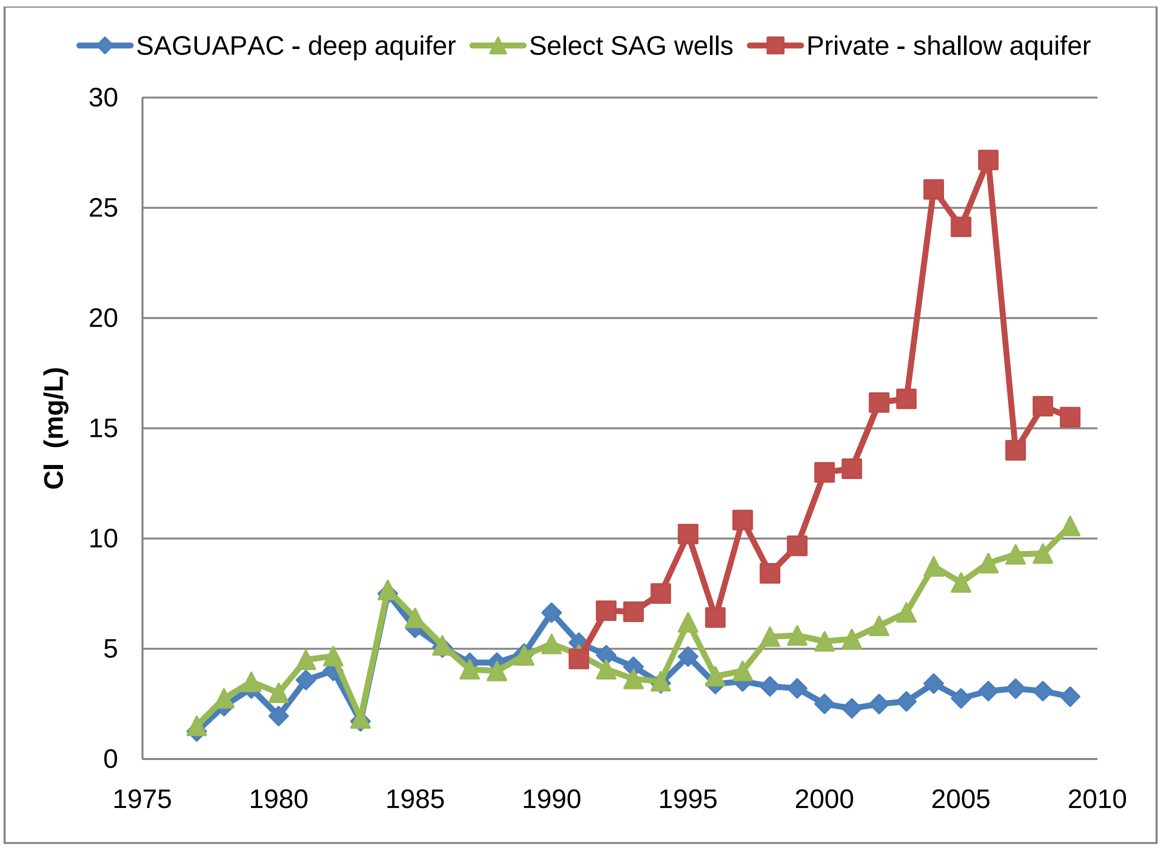

Figure 23. Concentration of chloride over time in deep aquifer public wells (SAGUAPAC) and shallow aquifer private wells. Select SAGUAPAC deep aquifer wells indicate wells that have been in production for the entire time period (1976-2009).

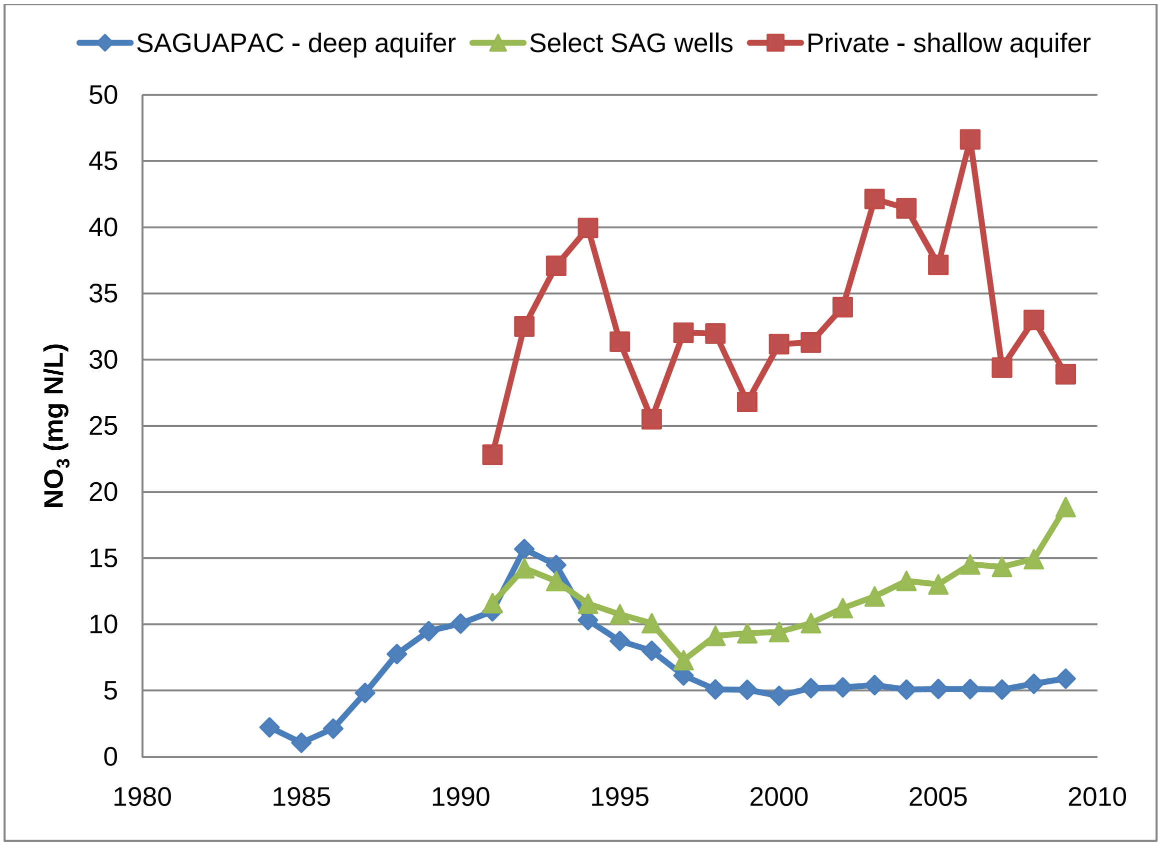

Figure 24. Concentration of nitrate over time in deep aquifer public wells (SAGUAPAC) and shallow aquifer private wells. Select SAGUAPAC deep aquifer wells indicate wells that have been in production for the entire time period (1976-2009).

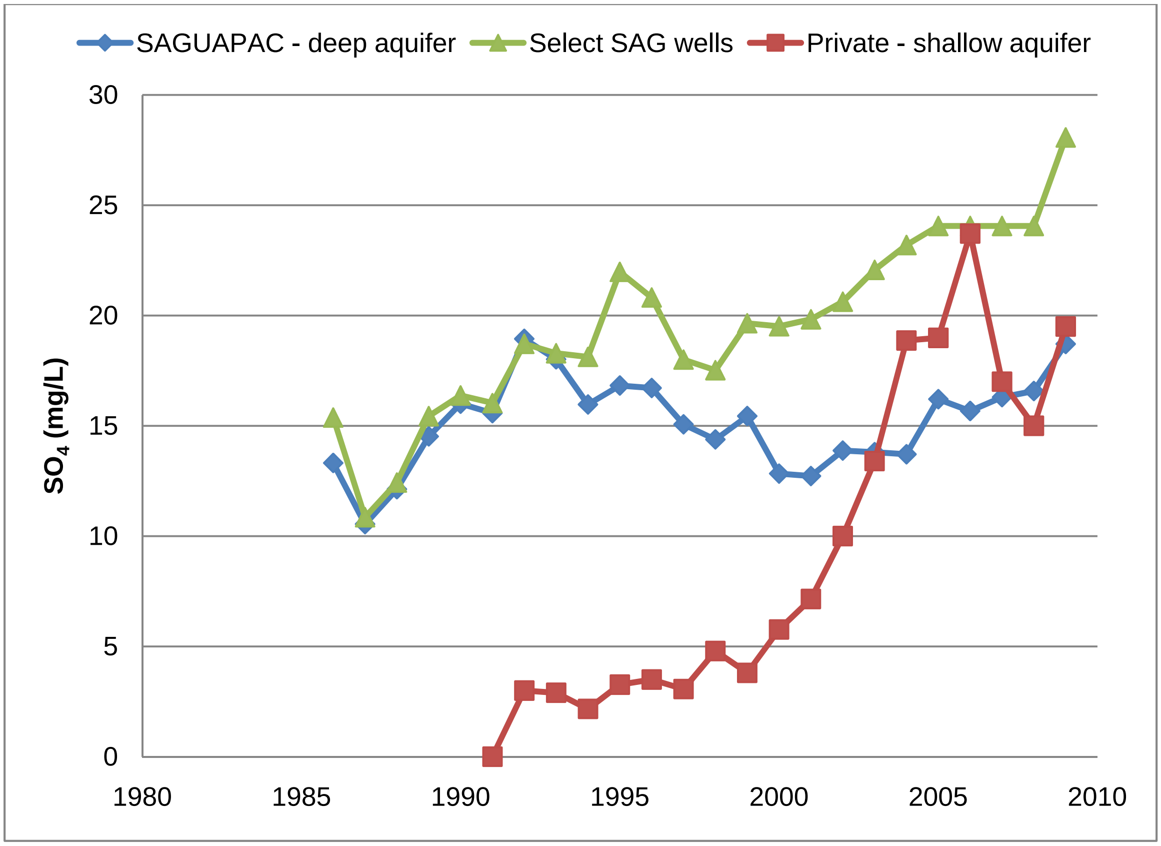

Figure 25. Concentration of sulfate over time in deep aquifer public wells (SAGUAPAC) and shallow aquifer private wells. Select SAGUAPAC deep aquifer wells indicate wells that have been in production for the entire time period (1976-2009).

Overall, the aquifer system beneath the city of Santa Cruz has been resilient in absorbing the urban-derived recharge by naturally attenuating contaminants. These processes have been aided by dilution from both subsurface pluvial recharge, throughflow and aquifer storage in the deeper layers (BGS & SAGUAPAC, 1997). However, as mentioned before, the loss of stormwater drainage through the expansion of the drainage network will reduce this higher quality source of recharge.

5.3 Methods

5.3.1 Data

Obtaining sufficient hydrologic data was a considerable challenge in the relatively young city of Santa Cruz. The majority of available data were not consistently collected before the 1970s, with many data sources having limited sampling points and/or significant record gaps. Technological and political issues also presented challenges to obtaining historical and current data.

The data used in this research was collected over a two year period by the author making three visits to Santa Cruz, or obtained via colleagues living in the city; however, the majority of data collection occurred in June 2010 (Table 25). All data collected in Santa Cruz required a formal written letter outlining the purpose of the study and a justification for any data requests. Numerous office visits were required to first submit the request letter, which had to receive top approval, and then one or more visits to collect the data. Furthermore, the data were not always available in a digital format and had to be either photocopied or copied using a camera (to create an instant "digital" copy). This occasionally limited the amount of data that could be obtained from a given office.

Table 25. Data obtained from Santa Cruz, Bolivia, including the source and available years.

Data Type	Source	Years
Meteorological	Municipal report	1946-1972
	AASANA (Administración de Aeropuertos y Servicios Auxliares a la Navegación Aérea)	1970-2010
	SEARPI (Servicio de Encauzamiento de Aguas y Regularización del río Piraí)	1972-1999
Census	INE (Instituto Nacional de Estadística)	1950, 1976, 1991, 2001
Water quality	BGS (British Geological Survey)	1970s-1994
	Governor's Office	1972, 2006
	SAGUAPAC (Cooperativa de Servicios Públicos Santa Cruz)	1991-2009
	Private Wells	1991-2009
Streamflow	Municipal report	1945-1966
	SEARPI	1986-1992
Sanitation	Municipal report	1971, 1981
	BGS	1990s
	SAGUAPAC	2000s
Potable water	BGS	1970-1990
	Water cooperatives	2000s

A variety of meteorological data (e.g., precipitation, temperature, wind speed, relative humidity) was obtained for the Trompillo airport station in Santa Cruz, which is located southeast of the city center in District 4, from AASANA (Administración de Aeropuertos y Servicios Auxliares a la Navegación Aérea). Additional rainfall data was obtained from the Angostura station on the Piraí River from SEARPI (Servicio de Encauzamiento de Aguas y Regularización del río Piraí) (Figure 22).

Census data was obtained from the Santa Cruz branch of INE (Instituto Nacional de Estadística). Data for the four census records (1950, 1976, 1991, and 2001) were collected at different spatial scales (e.g., by ring road, UV (neighborhood unit), barrio (neighborhood), and city-wide) due to the rapidly changing city structure. Furthermore, only the 2001 census included socio-demographic data such as literacy, employment, housing, and access to basic services. Collectively, this data was combined with historical maps and reports to extrapolate urbanization over time.

Water quality data was primarily obtained from the various water cooperatives as well as the British Geological Survey (BGS). The largest water cooperative, SAGUAPAC (Cooperativa de Servicios Públicos Santa Cruz), provided the most complete water quality record, although restrictions were placed on historical data due to the sensitive situation of water resources in Santa Cruz (i.e., decreasing water levels and declining water quality). Groundwater level data were deemed confidential and were not available.

Limited streamflow data were obtained for one station (Angostura) on the Piraí River, which is a tributary of the Amazon River from SEARPI. Although the Piraí River Basin has a total area of 13,395 km^2 and an elevation range of 200 to 2,800 m above mean sea level, the upstream station of Angostura is at an elevation of approximately 600 m and has a basin area of only 1,416 km^2 (Ingenieria del Agua, 2006).

Other essential data such as soils, land use, sanitation, potable water, and drainage canals were all obtained from a variety of sources, but primarily included the individual water cooperatives, the British Geological Survey, and historical reports.

The British Geological Survey (BGS & SAGUAPAC, 1995; Gooddy et al., 1997) conducted the first known water balance for the city of Santa Cruz. Based on this research they determined the main components of the urban water balance, which included pumped groundwater, seepage and leakage of piped water and wastewater, pluvial and riverine infiltration, and throughflow (both towards and away from the city) (Table 26).

Table 26. Hydrologic parameter value estimations from Santa Cruz (BGS & SAGUAPAC, 1995)

Parameter	Estimated	Time Period
Evaporation	100-175 mm/month	February – November
Average Rainfall (recharge)	171 mm/month	November – February
Average excess rainfall over pan evaporation	210 mm/year	1972-1992
Pumped Groundwater Public wells Private wells	 9,700 m^3/day 25,000 m^3/day (min)	1990
Groundwater withdrawals	$37.3x10^6$ m^3/year (equivalent to 257 mm depth over city)	1990
Shallow aquifer recharge	180 mm/year	1990
Sewered wastewater	$5.7x10^6$ m^3/year (39 mm equivalent)	1990
Consumptive use	$5.6x10^6$ m^3/year (38 mm equivalent)	1990
Recharged abstracted groundwater	$26x10^6$ m^3/year	1990
Throughflow	$24.6x10^6$ m^3/year	1980s
Average hydraulic conductivity	7-12 m/day	1980s
Aquifer transmissivities	660-890 m^2/day	1990
Aquifer storage coefficients (semi-confined/semi-unconfined)	0.0008-0.001	1990
Impermeable land surfaces	40%	1990
Groundwater velocity	27-79 m/year	1996

5.3.2 Monthly Water Balance Model

The *abcd* model was developed by Thomas (1981) and is a nonlinear watershed model that uses four parameters, which have a physical interpretation and relate to runoff characteristics and groundwater. Inputs to the model include precipitation (P) and potential evapotranspiration (PE) while outputs include overland runoff (R_o), groundwater outflow (Q_g), soil moisture (S_w), and groundwater storage (S_g) (Figure 26).

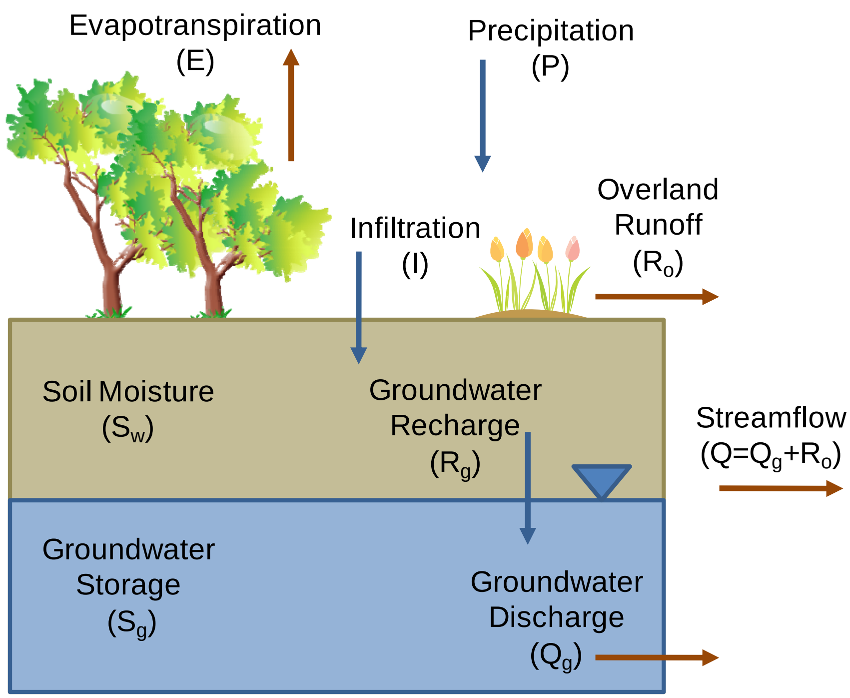

Figure 26. Schematic of the *abcd* water balance model compartments.

The methodology outlined in Serrano (1997) was applied for this study, with the water balance written as follows, based on a monthly time step *t* (units are mm/month):

$$P(t) - E(t) - R_g(t) - R_o(t) = \Delta S_w = S_w(t) - S_w(t-1) \tag{1}$$

where

P	=	Precipitation
E	=	Evapotranspiration
R_g	=	Groundwater recharge
R_o	=	Overland (direct) runoff
ΔS_w	=	Change in soil moisture or soil-water content
S_w	=	Soil moisture

Rearranging equation (1):

$$\left[P(t)+S_w(t-1)\right]-\left[E(t)+S_w(t)\right]=R_o(t)+R_g(t) \tag{2}$$

The left side of equation (2) highlights two terms that Thomas defined as the available water, *W(t)*, and evaporation opportunity, *Y(t)*, or water that will eventually leave the basin in the form of evapotranspiration (Fernandez et al., 2000):

$$W(t)=P(t)+S_w(t-1) \tag{3}$$

$$Y(t)=E(t)+S_w(t) \tag{4}$$

Therefore, equations (3) and (4) can be substituted into equation (2) to obtain:

$$W(t)-Y(t)=R_o(t)+R_g(t) \tag{5}$$

The soil moisture is assumed to decay exponentially within each time interval as follows:

$$S_w(t)=Y(t)e^{-PE(t)/b} \tag{6}$$

where

PE = Potential evapotranspiration (estimated from equations (15) and (16) below)

The relationship between the available water and evaporation opportunity is given as:

$$Y(t)=\frac{W(t)+b}{2a}-\left[\left(\frac{W(t)+b}{2a}\right)^2-\frac{W(t)b}{a}\right]^{0.5} \tag{7}$$

where *a* and *b* are parameters calculated from precipitation, evapotranspiration, and soil moisture values (Serrano, 1997). The parameter *a* (ranges from 0 to 1) reflects "the propensity of runoff to occur before the soil is fully saturated" (Thomas, 1981). In flat landscapes with low drainage density, the value of *a* approaches 1, while urbanization and deforestation result in decreased values. Parameters *a* and *b* are related by:

$$a = 2b / Y(b) - \left(\frac{b}{Y(b)} \right)^2 \tag{8}$$

The difference between available water and evaporation opportunity, *W(t) – Y(t)*, as shown in equation (5), is the sum of overland or surface runoff, R_o, and groundwater recharge, R_g. The portion of streamflow that comes from groundwater is determined using parameter *c*, which partitions the difference *W(t) – Y(t)* between overland runoff and groundwater recharge as follows:

$$R_o(t) = (1-c)\left(W(t) - Y(t)\right) \tag{9}$$

$$R_g(t) = c\left(W(t) - Y(t)\right) \tag{10}$$

The fraction of groundwater storage discharged is expressed by parameter *d*, which relates groundwater flow as a direct function of the groundwater storage:

$$Q_g(t) = dS_g(t) \tag{11}$$

The water balance for the groundwater reservoir is thus written as:

$$R_g(t) - Q_g(t) = \Delta S_g = S_g(t) - S_g(t-1) \tag{12}$$

By substituting equation (11) into equation (12), the groundwater storage expression can be written as:

$$S_g(t) = \frac{R_g(t) + S_g(t-1)}{d+1} \tag{13}$$

If the subsurface flow component is omitted, the streamflow expression is:

$$Q(t) = R_o(t) + Q_g(t) \tag{14}$$

The potential evaporation (equation 6) was estimated using the Thornthwaite equation for humid areas, as shown in Serrano (1997):

$$PE(t) = k_m k_1 \left(\frac{10 T_a(t)}{J} \right)^{k_2 J^3 + k_3 J^2 + k_4 J + k_5} \qquad (15)$$

$$J = k_6 \sum_{t=1}^{12} T_a^{1.514}(t) \qquad (16)$$

where

k_m = Monthly correction constant function of latitude (see Table 27)

k_1 = 16.0 mm/month

k_2 = 6.75×10^{-7} $^0C^{-3}$

k_3 = -7.71×10^{-5} $^0C^{-2}$

k_4 = 1.792×10^{-2} $^0C^{-1}$

k_5 = 0.49239

k_6 = 0.0874 $^0C^{-0.514}$

T_a = Mean monthly air temperature (^{0}C)

J = Annual heat index (^{0}C)

Table 27. Correction constant (k_m) for latitudes 10^{o}S and 20^{o}S (Santa Cruz, Bolivia is located at latitude 17^{o}S).

Latitude	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
10 ^{0}S	1.05	1.04	1.02	0.99	0.97	0.96	0.97	0.98	1.00	1.03	1.05	1.06
20 ^{0}S	1.10	1.07	1.02	0.98	0.93	0.91	0.92	0.96	1.00	1.05	1.09	1.11

Actual evapotranspiration (E) was not available from observed records; therefore, it was estimated by re-arranging equation (4) to obtain the following expression:

$$E(t) = Y(t) - S_w(t) \qquad (17)$$

A comparison of the mean annual aridity index (PE/P) versus the mean annual evapotranspiration ratio (E/P, indicating wetness) can be used to characterize the long-term hydroclimatology of region (Sankarasubramanian et al., 2002). An aridity index greater than one indicates a more arid region while ratios less than one indicate more humid region (Martinez et al., 2010). The aridity index can also be used to indicate the general effect of climate change on annual runoff (Arora, 2002).

5.3.3 Model Calibration

Observed streamflow data (1986-1992) at the Angostura station on the Piraí River (Figure 22) was used to calibrate the *abcd* water balance model. The four model parameters were determined by minimizing the sum of squares of errors between monthly observed and predicted streamflow values. The objective function is expressed as follows:

$$F = \sum_{t=1}^{N} \left(Q_o(t) - Q_s(t) \right)^2 \tag{18}$$

where

Q_o = observed streamflow

Q_s = simulated streamflow

N = total number of months of observed streamflow

Initial values for soil moisture (S_w) and groundwater storage (S_g) were allowed to vary to obtain the best fit during the optimization.

5.3.4 Scenario Development

To simulate changes in urbanization, population growth, and land use between 1970 and 2050, the parameter values were modified every 20 years – 1970, 1990, 2010, and 2030. A 20 year-interval was selected based on historical urbanization trends in

Santa Cruz as well as data availability. Prior to 1970, it can be assumed that pre-urban conditions were present. However, between 1970 and 1990, the population of Santa Cruz roughly doubled each decade, and although population growth continued between 1990 and 2010, growth slowed per decade during this time period. Furthermore, in recent years, new city limits have been delineated, thus indicating that in the next decade or two, growth will continue to slow. It was therefore assumed that between 2010 and 2030 a final period of urban expansion will occur, and 2030-2050 will be characterized by stable growth as the majority of available land will have been developed within the city limits; however, there are no geographical barriers to restrict eastern expansion beyond these city limits.

Three scenarios were developed to evaluate changes in land use over time. The first development scenario, *moderate growth*, is characterized by modest growth, gradual increase in basic services (including the stormwater network), and minimal preservation of green space. The second scenario, *coordinated growth*, represents more sustainable and planned growth characterized by higher-density development, the provision of basic services, designated or preserved green spaces in new developments, and integrated management of stormwater. The third development scenario, *rapid growth*, represents a "business-as-usual" development trend, with sustained, unplanned growth in peri-urban areas characterized by a lack of basic services, continued loss of green space, and complete reliance on drainage canals for stormwater management.

Table 28 provides the parameter values for each development scenario over the four time periods. For each scenario, the two historical time periods (1970-1989 and 1990-2009) have the same parameter values, with the optimized parameter values applied to the first time period. The model parameters were modified based on the standard deviations of the parameter ranges for 46 southeastern basins (Martinez, 2011). All estimated parameter values are within expected ranges reported by previous studies (Alley, 1984; Fernandez et al., 2000; Martinez & Gupta, 2010; Vandewiele et al., 1992).

Table 28. Calibrated or estimated model parameter values over time representing three development scenarios.

<table>
<tr><th>Scenarios</th><th>Parameter</th><th>1970*</th><th>1990</th><th>2010</th><th>2030</th></tr>
<tr><td rowspan="4">Moderate</td><td>a</td><td rowspan="3">0.9995</td><td rowspan="3">0.9900</td><td>0.9800</td><td>0.9700</td></tr>
<tr><td>b</td><td>1665.3</td><td>1640.3</td></tr>
<tr><td>c</td><td>0.1767</td><td>0.1267</td></tr>
<tr><td>d</td><td rowspan="3">1715.3</td><td rowspan="3">1690.3</td><td>0.0015</td><td>0.0016</td></tr>
<tr><td rowspan="4">Coordinated</td><td>a</td><td>0.9850</td><td>0.9800</td></tr>
<tr><td>b</td><td>1675.3</td><td>1660.3</td></tr>
<tr><td>c</td><td rowspan="3">0.2767</td><td rowspan="3">0.2267</td><td>0.1967</td><td>0.1667</td></tr>
<tr><td>d</td><td>0.0019</td><td>0.0020</td></tr>
<tr><td rowspan="4">Rapid</td><td>a</td><td>0.9750</td><td>0.9600</td></tr>
<tr><td>b</td><td rowspan="3">0.0013</td><td rowspan="3">0.0014</td><td>1655.3</td><td>1620.3</td></tr>
<tr><td>c</td><td>0.1567</td><td>0.0867</td></tr>
<tr><td>d</td><td>0.0029</td><td>0.0044</td></tr>
</table>

*Indicates parameters determined from model calibration

To account for temporal changes resulting from climate change, projected monthly temperature and precipitation values were estimated from 2011 through 2050 based on three emission scenarios published by the Intergovernmental Panel on Climate Change (IPCC) – A1B, B1, and A2. Key assumptions for each emission scenario include the following (IPCC, 2011):

- A1B – Very rapid economic growth, low population growth and rapid introduction of new and more efficient technology

- B1 – Convergent world with low population growth, rapid changes in economic structures toward a service and information economy, with reductions in materials intensity, and the introduction of clean and resource-efficient technologies
- A2 – Heterogeneous world with strengthening regional cultural identities, high population growth, and less concern for rapid economic development

Changes in precipitation and air temperature were determined using the GFDL-CM2.1 coupled climate model for two time periods, 2010-2039 and 2040-2069. Average measured monthly precipitation and temperature values (1970-2010) were used along with projected changes to estimate monthly values for 2039 and 2069. A monthly linear incremental factor was then determined for each time period to calculate monthly precipitation and temperature values for 2011 to 2038 and 2040 to 2050. Observed and predicted monthly values for precipitation and temperature are provided in Appendix D.

5.4 Results

The *abcd* monthly water balance model was calibrated by optimizing the four parameters and initial values of soil moisture (S_g) and groundwater storage (S_g) to minimize the monthly error between observed and simulated streamflow. Figure 27 shows the fit of the observed and simulated streamflow (residual sum of squares of errors is 61569.6 mm^2 or 0.663 ft^2), which is satisfactory given the uncertainty in the observed data.

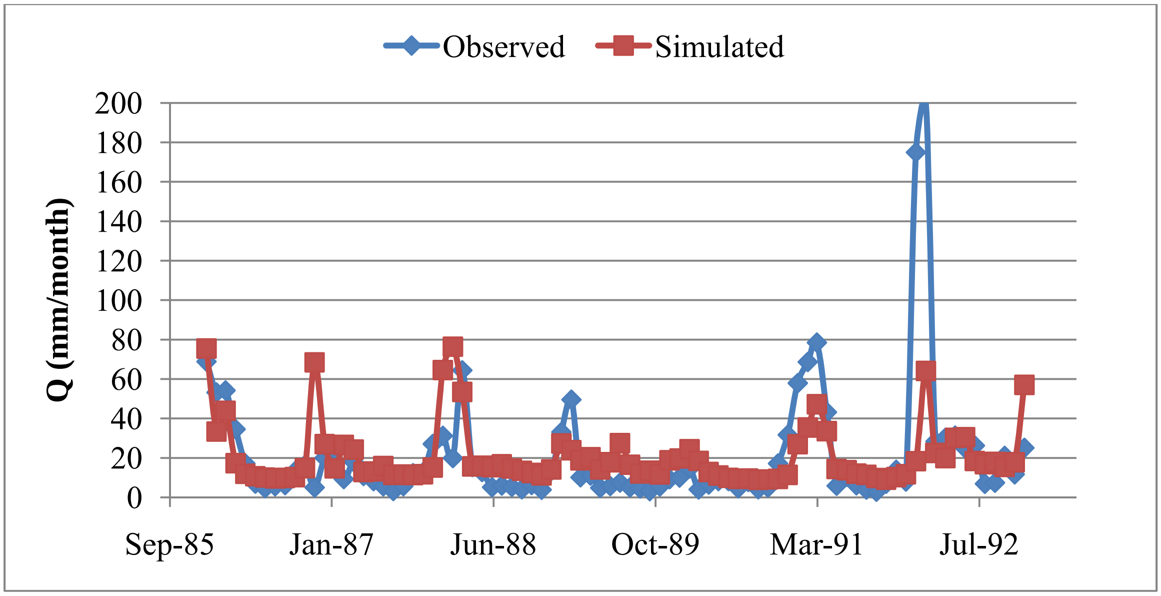

Figure 27. Model calibration (observed versus simulated streamflow) for the six years of observed data (1986-1992) at the Angostura station on the Piraí River.

Hydroclimatology descriptors such as annual aridity index (*PE/P*) and evaporation ratio (*E/P*) are shown in Figure 28 and the correlation between them is provided in Figure 29. The mean annual values for the four time periods for the aridity index ranged from 1.1-1.3 and for the evaporation ratio from 0.7-0.9. These values compare well with the hydroclimatic data for 46 catchments in the southeastern region of the U.S., which range between 0.8-1.2 (*PE/P*) and 0.5-0.8 (*E/P*) (Martinez & Gupta, 2010). The southeast region has similar precipitation patterns to Santa Cruz, including seasonal rainfall and annual averages (53 in/year vs. 51 in/year for Santa Cruz) and relative humidity (average 72% vs. 70%, respectively), but lower annual air temperature (average 67^{0}F vs. 76^{0}F, respectively), and lower average wind speed than Santa Cruz (average 8 mph vs. 13 mph, respectively) (AASANA; National Climatic Data Center, 2011).

Figure 28 reveals a historical decreasing trend for the annual aridity index until the early 1980s and a gradual increasing trend until 2040, which becomes stronger through 2050; while the annual evaporation ratio shows a similar decreasing trend as the aridity index until the early 1980s, however, this becomes a more gradual decrease through the early 2000s, and a stable or slightly increasing trend through 2050.

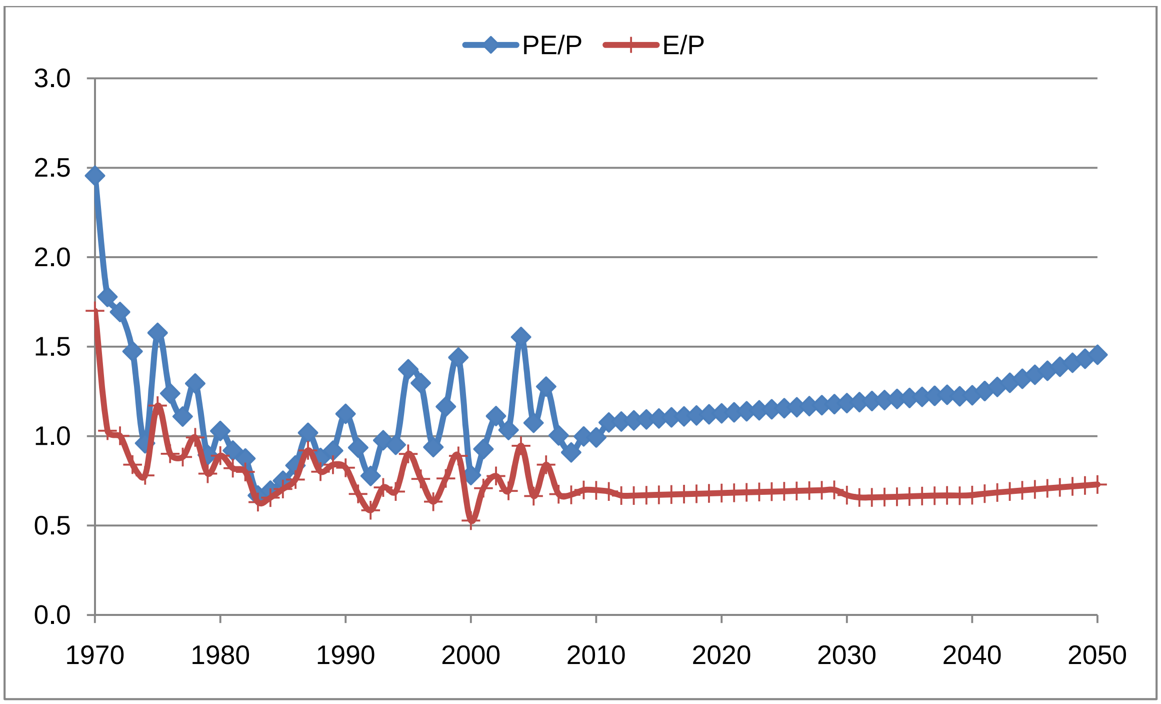

Figure 28. Annual evapotranspiration ratio (*E/P*) and aridity index (*PE/P*) for Santa Cruz, Bolivia illustrating historical trends (1970-2010) and projected future trends (2011-2050) based on IPCC emissions.

The slight positive correlation between the aridity index and evaporation ratio (Figure 29) indicates a long-term shift in the regional hydroclimatology towards less humid conditions. Based on future climate projections for the Santa Cruz region, potential evapotranspiration is expected to exceed precipitation, indicating that actual evaporation will also increase and approach actual precipitation over time. Furthermore, although relative humidity was not examined in this analysis, a study examining the climate variability of northeastern Brazil (1960-1990) noted a decrease in relative humidity and an increase in evaporation with increasing air temperatures (Silva, 2004). A general shift from humid conditions to sub-humid conditions was also noted in many regions in Turkey between 1960 and 1990, with significant upward trends in the aridity index (attributed to decreases in precipitation), which is expected to continue to decrease based on future regional climate projections (Silva, 2004).

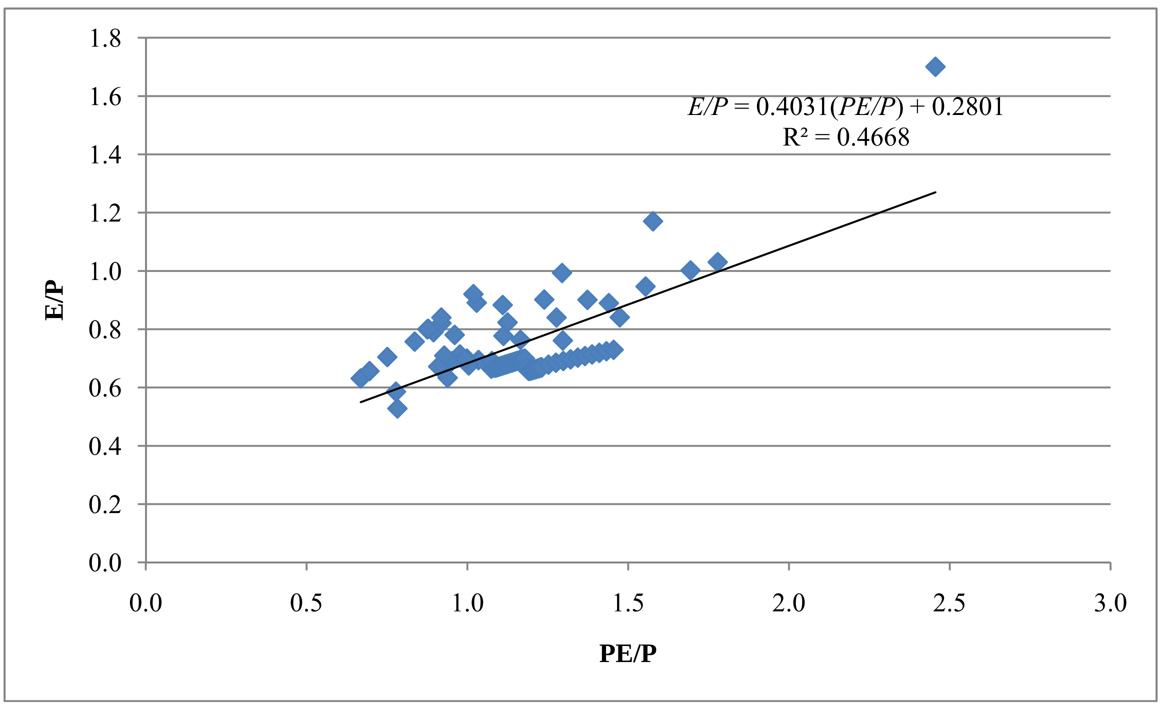

Figure 29. Comparison of annual evapotranspiration ratio (*E/P*) vs. aridity index (*PE/P*).

Figure 30 illustrates the annual aridity index for future climate projections based on the three emission scenarios. The A2 emission scenario represents a relative average between the other two scenarios; however, in all cases the aridity index is increasing over time, with more dramatic increases occurring after 2040. Although the aridity index influences the long-term water balance, other factors such as land use change are important considerations and are discussed below.

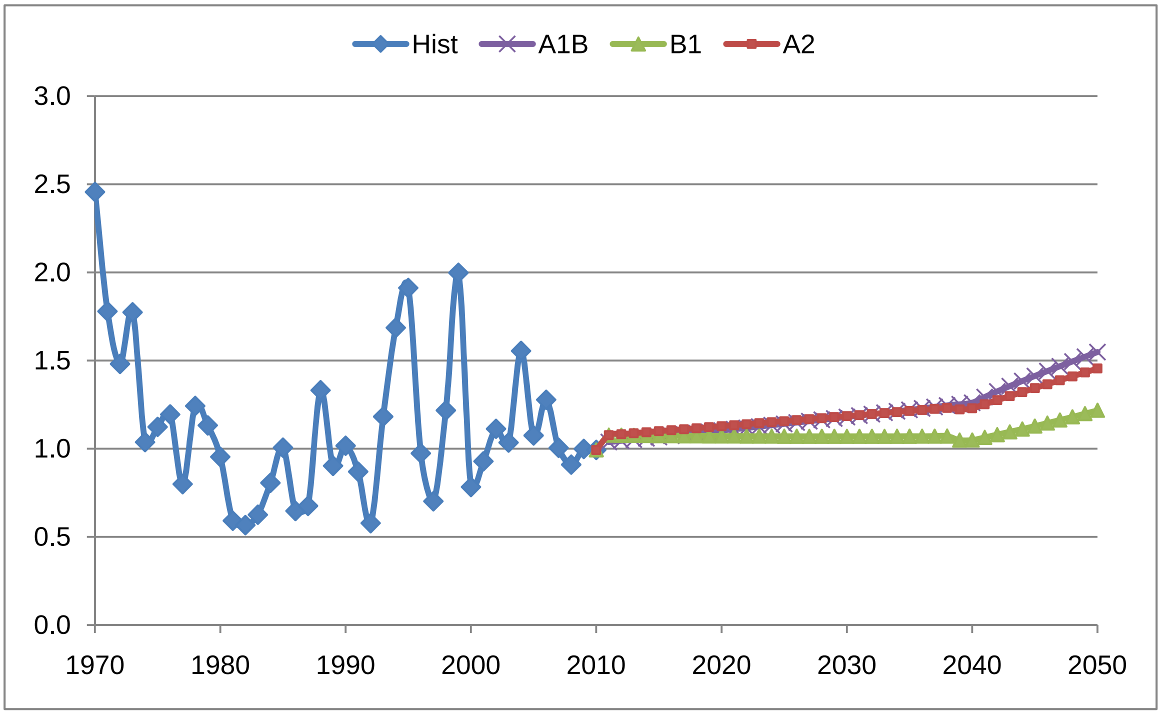

Figure 30. Annual aridity index for Santa Cruz, Bolivia, including historical values (1970-2010) and future climate projections (2011-2050) based on the three emission scenarios, A1B, A2, and B1.

Regardless of the scenario, the two largest components of the water balance model are soil moisture (S_w) and groundwater storage (S_g) (shown on the right axis of Figure 31, based on the moderate growth and A2 temporal scenarios). With the exception of potential evapotranspiration (*PE*) and actual evapotranspiration (*E*), the remaining components show stable or decreasing future trends. The historical precipitation trend (1970-2010) was generally positive with several wet periods with consistent above average annual precipitation (1330 mm/year): 1981-1994 (with a year break in 1989), 2000-2003, and 2007-2010; along with the following dry periods: 1970-1973, 1975-1978, and 1995-1999. The year 1997 corresponds to the coldest year from

1970 to 2010, with an average temperature of only 19.5°C (compared to the long-term average of 24.2°C), and the lowest actual and potential evapotranspiration values of the entire record. Although groundwater recharge (R_g) represents a small portion of the overall water balance, it is important to note that after the early 2000s, the annual value decreases gradually through 2050, which in turn contributes to decreasing groundwater storage (S_g).

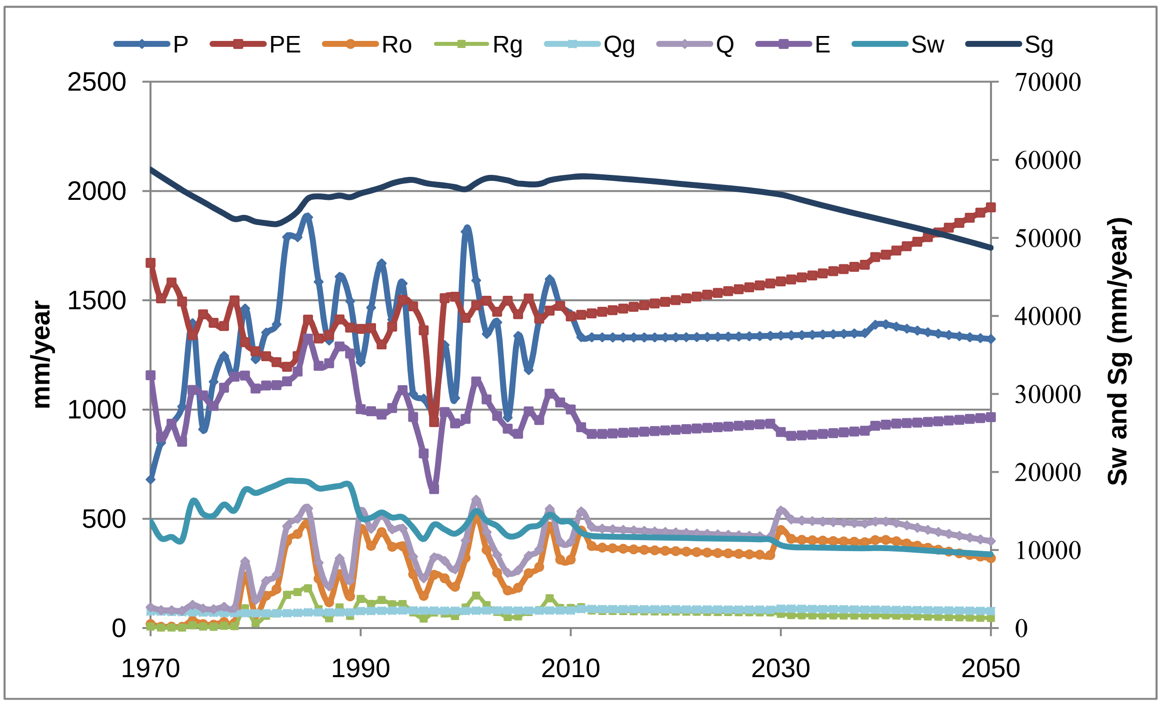

Figure 31. Annual water balance model output based on the moderate growth scenario and A2 temporal scenario.

All three growth scenarios indicate decreases in available water (W) and evaporation opportunity (Y), with the rapid growth scenario resulting in the greatest decreases (Table 29). Both the moderate and rapid growth scenarios produce increased overland runoff (R_o), with corresponding increases in groundwater discharge (Q_g) and streamflow (Q), while the moderate growth scenario maintains values similar to those during the second time period (1990-2009). The land use change assumptions made in the rapid growth scenario (e.g., less green space, reliance on drainage canals) result in decreased actual evapotranspiration (*E*) and groundwater recharge, with significantly higher streamflow. This indicates increased potential for flooding, continued decrease of groundwater levels, and accelerating groundwater contamination due to a lack of natural groundwater recharge. Based on this analysis, the coordinated growth scenario produces the smallest impact to the current urban hydrology in Santa Cruz.

Table 29. Comparison of mean monthly water balance outputs for the moderate, coordinated, and rapid growth scenarios (future temporal components based on the A2 emission scenario).

	1970-1989	**1990-2009**	**2010-2029**			**2030-2050**		
			Moderate	**Coordinated**	**Rapid**	**Moderate**	**Coordinated**	**Rapid**
W	1460.6	1225.9	1086.9	1135.7	1046.8	953.2	1024.4	898.9
Y	1444.3	1192.6	1050.9	1103.3	1008.0	916.8	993.4	858.5
S_w	1351.4	1112.0	974.6	1023.7	934.4	839.9	911.1	785.6
R_o	11.8	25.7	29.5	26.0	32.6	31.8	25.8	36.9
R_g	4.5	7.5	6.4	6.4	6.2	4.6	5.2	3.5
S_g	4539.0	4744.8	4749.4	4771.0	4137.8	4349.5	4503.5	2435.6
Q_g	5.9	6.7	7.1	6.9	11.7	7.0	6.8	10.7
Q	17.7	32.4	36.7	32.9	44.3	38.8	32.6	47.7
E	92.9	80.6	76.2	79.6	73.5	76.9	82.3	72.9

A critical issue impacting water resources in Santa Cruz is extensive environmental degradation caused by large-scale deforestation due to agricultural development (a driver of desertification that is already impacting many areas of Bolivia). Rapid deforestation has already caused increased surface water runoff, reduced aquifer recharge, and increased soil moisture loss in many areas of Bolivia (US Army Corps of Engineers, 2004) and can be compounded by land use changes due to urbanization (as in Figure 31). Decreased amounts of green space (i.e., vegetation cover) also causes increased soil erosion that negatively impacts surface water bodies. In peri-urban areas of Santa Cruz, the loss of green space has also created conditions conducive to sand storms, which are common during winter wind events. These sand storms not only reduce the quality of life of residents, but also increase the maintenance associated with urban water infrastructure, which clog with sand and contribute to flooding. The increased maintenance requirements of earthen infrastructures lead to the adoption of concrete-lined canals by the municipal government that are more costly to construct and pose negative impacts to long-term groundwater recharge and water quality, but eliminate the need for yearly maintenance.

Flooding not only results in economic impacts, such as damage to infrastructure and crops, but also health impacts due to the increased risk of disease outbreaks (American Red Cross, 2010). Due to the flat topography and clay soils in areas, flooding is a yearly occurrence in the peri-urban areas of Santa Cruz. In 2009, high rainfall combined with poor stormwater drainage and solid waste management (i.e., garbage trapped standing water or clogged infrastructure) resulted in an outbreak of dengue fever, with a mortality rate greater than 21% in Bolivia (the department of Santa Cruz had more than 70% of the suspected cases of dengue) (IFRC, 2009). Furthermore, the social, economic, and environmental impacts associated with flooding events disproportionately affect residents in peri-urban areas due to significantly lower access to basic services and development on marginal land (Gobierno Municipal de Santa Cruz de la Sierra, 2004).

In addition to the threat of flooding due to rapid conveyance of stormwater in more heavily urbanized landscapes, the reduction in natural (and relatively high quality) recharge threatens water resources in Santa Cruz in two ways: 1) less dilution of urban-derived recharge – thus negatively impacting water quality; 2) exploitation of the aquifer system with decreasing groundwater levels – making it more difficult and expensive to reach high quality groundwater. Therefore, while land use changes due to urbanization indicate negative impacts on the urban hydrology, the issue of potable water may be a question of degrading water quality, and not just water quantity. This has social and economic impacts for residents and businesses relying on water withdrawn from the degraded shallow or intermediate aquifer levels, as well as economic and politic impacts for the water cooperatives that are charged with supplying sufficient quantities of potable water at affordable rates.

As previously mentioned, land use changes are not the only factors that influence the water balance. Table 30 provides the changes in the mean monthly outputs based on the three temporal scenarios A2, B1, and A1B (using model parameter values based on the moderate growth scenario). The A1B scenario produced the greatest decreases in precipitation and therefore resulted in decreases in soil moisture, groundwater recharge, groundwater storage, and actual evapotranspiration, while the B1 scenario produced the greatest increases in precipitation, which corresponds to increases in surface runoff, groundwater discharge, streamflow, and actual evaporation. However, it should be noted that the rapid growth scenario produced significantly greater changes to the water balance in regards to soil moisture and groundwater recharge, storage, and discharge. Overall this indicates that extensive land use changes (i.e., reduction in permeable surfaces and natural groundwater recharge) can produce considerable impacts on urban hydrology, namely the groundwater component.

Table 30. Comparison of mean monthly water balance outputs for the A2, B1, and A1B temporal scenarios (model parameters based on the moderate growth scenario).

	1970-1989	1990-2009	2010-2029			2030-2050		
			A2	B1	A1B	A2	B1	A1B
P	109.2	112.2	111.5	116.9	109.8	112.5	130.7	104.8
PE	115.2	118.1	124.9	124.0	124.8	143.9	138.6	144.3
W	1460.6	1225.9	1086.9	1118.0	1078.8	953.2	1055.8	914.6
Y	1444.3	1192.6	1050.9	1078.5	1043.8	916.8	1006.7	882.7
S_w	1351.4	1112.0	974.6	1000.7	968.1	839.9	924.8	808.8
R_o	11.8	25.7	29.5	32.5	28.7	31.8	42.9	27.9
R_g	4.5	7.5	6.4	7.1	6.3	4.6	6.2	4.0
S_g	4539.0	4744.8	4749.4	4791.2	4737.0	4349.5	4620.1	4265.6
Q_g	5.9	6.7	7.1	7.2	7.1	7.0	7.4	6.8
Q	17.7	32.4	36.7	39.6	35.8	38.8	50.3	34.8
E	92.9	80.6	76.2	77.8	75.6	76.9	82.0	73.8

Reductions in the available water (and thus soil moisture and groundwater storage) due to projected temporal changes has significant implications for many ecosystems in Santa Cruz that have already been degraded or fragmented due to urbanization or agricultural activities. The previously discussed changes in urban hydrology due to land use alterations (i.e., increased runoff, decreased groundwater recharge, decreased soil moisture, etc) also have the potential to modify rainfall patterns and soil composition and decrease biodiversity (US Army Corps of Engineers, 2004). Therefore, the increasing temporal trends towards a more arid climate could trigger additional stresses on natural systems due to increased demand for irrigation and drinking water, decreased base flows, and increased loadings of pollutants relative to natural recharge.

In Santa Cruz and other parts of Bolivia (as well as other developing countries), the most serious water resource (and land management) problems are inter-related and include: rapid urbanization, limited access to sanitation, the lack of a national water law (and resulting poor water management), lax enforcement of existing environmental regulations, multiple agencies responsible for water management, and overexploitation of groundwater systems (US Army Corps of Engineers, 2004). To address these considerable issues, long-term solutions much incorporate integrated water management combined with green space conservation and increased education and awareness by residents of the use of water resources as well as land uses.

5.5 Discussion and Future Research

Using a regional monthly water balance model, future impacts on the urban hydrology in Santa Cruz were examined based on temporal changes from the three emission scenarios (A2, B1, and A1B) and spatial changes from three growth scenarios (moderate, coordinated, and rapid). Although future temporal changes based on scenario A1B indicate decreasing precipitation and A2 and B2 indicate stable or increasing precipitation, all temporal scenarios indicate increasing potential evapotranspiration over time. Therefore, the aridity index (*PE/P*) is anticipated to increase for all three emission scenarios. This has important implications for the hydroclimatology of the region, which shows indications of becoming more arid over time. Although effective solutions to climate change require international attention, at the local or regional level, more sustainable land uses can be implemented to minimize the negative impacts of these future temporal changes. These land use changes could include integrated watershed management (e.g., greater integration (and protection) of existing wetlands and green spaces in peri-urban areas as part of a regional stormwater management approach, protection of groundwater recharge areas) and coordinated development that ensures the provision of basic services while reducing the development of marginal land.

Both spatial and temporal changes impact urban hydrology, yet the results of this study indicate that extensive land use changes (i.e., rapid growth) can impact urban hydrology as great or greater relative to temporal changes (e.g., decreases in actual evaporation, groundwater recharge, soil moisture, and groundwater storage, increases in groundwater). Unfortunately, current land use trends in Santa Cruz (characterized by car-oriented, low-density, sprawl developing) indicate future growth similar to the moderate or rapid scenarios. Despite numerous reports addressing long-term solutions to urbanization, solid waste management, water resources, etc, very little coordination exists between urban planners, city officials, engineers, and other service providers. As a result land use and water management decisions are made in a piece-meal fashion that relies on expensive and time-consuming construction of urban infrastructures to compensate for degraded or destroyed ecosystem cycles and services. At the same time, urban quality of life is decreased while environmental degradation is increased (including resulting human health impacts from air, water, and soil contamination), access to public open spaces is decreased, mobility and pedestrian safety are decreased (due to the dominance of infrastructures designed for motorized vehicles), and the cost of building and maintaining urban infrastructures is increased (again due low-density sprawl development). Collectively, current development patterns are reducing permeable surfaces, altering vegetation cover (i.e., native species to grass or other ornamental species), and replacing natural infrastructures (i.e., wetlands, forests, etc) with engineered systems that have modified the movement, distribution, and quality of water in Santa Cruz (Niemczynowicz, 1999).

Future development in Santa Cruz will therefore need to focus on increasing basic services in peri-urban developments, preserving green space (including open space and wetlands), and integrating stormwater management with natural systems to promote direct groundwater recharge. This will not only require political will and coordination between government agencies, but also environmental education to increase awareness of the impact of land use changes on urban amenities such as water resources and green space. In particular, urban planners should focus on designating groundwater recharge areas in sensitive areas (including the rapidly growing peri-urban areas in the south and southeast of the city), to limit informal settlements that lack essential basic services (BGS & SAGUAPAC, 1995).

Future research will first examine decadal oscillation in the data and whether it is associated with climate variability (i.e., Pacific Decadal Oscillation, El-Niño Southern Oscillation). Building on these results, future research will then examine different combinations of the spatial and temporal scenarios, as well as conduct statistical analyses of the model outputs. Additionally, changes in water quality will be evaluated by linking the water balance model outputs (e.g., groundwater recharge, discharge, and storage) with a water quality model to examine changes over time and at various depths. Due to the different aquifer layers, it is important to evaluate the acceleration of contaminants in the shallow, intermediate, and deep aquifers, including an anticipated time frame for contaminant dispersal. This has important social and economic implications for the protection and provision of safe drinking water, particularly for residents who rely on surface water or the upper aquifer for potable water. The expansion of the sanitation and the drainage canal networks will also have differing impacts on future hydrology. The expansion of sewers should be considered a priority, particularly in the vulnerable southern portion of the city where more permeable soils exist. The expansion of drainage canals should also be coupled with expansion of other permeable spaces to promote natural groundwater recharge. This integration of natural and engineered systems should be incorporated into a more sustainable land use framework that reduces negative impacts on urban hydrology.

Chapter 6: Conclusions, Recommendations, and Future Research

6.1 Conclusions

This research examined the impacts of urbanization on green space and urban hydrology using an interdisciplinary approach that combined engineering with anthropology, urban planning, and ecology. This research was analyzed within a sustainability framework that assessed linkages between social, environmental, and economic benefits and impacts of land use decisions within a developed and developing world context. The conducted research addressed the specific objectives outlined Section 1.3.

6.1.1 Objective 1

Objective 1 focused on identifying the social, environmental, and economic drivers of green space revitalization in a developing world context. Due to the under-utilized potential of brownfields, industrialized nations have begun to revitalize these sites, particularly those located along water features, as a way to enhance their economic, social, and/or environmental attributes. An important first step is identifying the desired benefits to be obtained through the revitalization process. This analysis identified similar environmental and social benefits of brownfields redevelopment from a developed world (U.S.) and a developing world (Bolivia) perspective. However, differences were more apparent in terms of anticipated economic benefits. Communities in the United States often benefit from increased jobs, tax revenues, and property values, whereas the economic benefits of brownfields redevelopment for Bolivian communities are more likely to result from reduced flooding, crime, and health risks. Therefore, in the case of Bolivia, these anticipated benefits would have significant impacts for the urban poor who often environmental justice issues in terms of the distribution of urbanization benefits (i.e., sanitation, road infrastructure, health care).

This research demonstrates the larger issue of brownfields redevelopment, which is the need to create a greater awareness of the connections between environmental degradation, human health impacts, and economic viability. However, in countries like Bolivia, there are few social or environmental protections and usually no established framework for preventing the creation of degraded spaces. Often the lack of basic services such as sanitation and solid waste management promotes the formation of these spaces. Therefore the actions of local communities can either contribute to further environmental degradation or they can work to become part of the solution. Individual actions could include composting of organic wastes, recycling acceptable items, and minimizing the use of non-reusable or non-recyclable items (i.e., plastic bags, Styrofoam). Reducing the amount of trash within the community would not only improve the aesthetics and reduce the need to burn waste, but it could also help reduce the spread of malaria and dengue fever (i.e., reducing items that collect water and provide a breeding ground for mosquitoes). However, long-term solutions are needed to address these complex development issues and although grass-root efforts are essential, top-down initiatives are important to sustain the impact of individual efforts. A first step for communities is therefore to take ownership of these problems and work to engage government officials and urban planners.

6.1.2 Objective 2

Objective 2 examined the preferences, perceptions, and barriers to accessing green spaces in a rapidly urbanizing city in the developing world. Two main types of green space were evaluated in Santa Cruz: large urban parks and small neighborhood parks. Residents generally preferred the large urban parks, which are newer and relatively uniform in appearance and amenities, due to the perception that these spaces have more amenities, are better maintained, and safer (i.e., patrolled, well lit, and fenced). Although there are considerably more small neighborhood parks located in closer proximity to more residents, these spaces are highly variable in terms of amenities, maintenance, visitors, and safety features.

This research exposed the importance of public green space for leisure and recreational activities for the urban poor. Yet the four main access barriers that were identified (i.e., distance, time, safety, and accessibility to desirable spaces) were found to disproportionately impact lower-income individuals and residents living in the peri-urban areas. Furthermore, systematic green space observations identified gender inequalities, with males using green spaces more frequently than females.

Although this analysis noted some reductions in access barriers due to the creation of new large urban parks within the last decade, it also highlighted the undervalued potential of the numerous smaller green spaces. Improving the usability of these smaller spaces will require that policy makers, urban planners, and community leaders support improvements to the quality, maintenance, safety, and diversity of existing and new spaces. In particular, green spaces in the peri-urban areas tend to be dominated by sport fields that have limited social amenities, which exclude women and elderly.

Based on the research findings, small neighborhood parks could be improved by adding social gathering sites, more diverse amenities (i.e., benches, playground equipment, BBQ pits), and natural features (i.e., vegetation, trees). Individual communities could also take ownership of their green spaces by removing trash, maintaining amenities, and using these spaces more regularly. Green space users reported feeling safer when there were more users (particularly families and elderly) and spaces were maintained. Understanding the perceptions and preferences of green space users, including barriers that limit access, can enable decision makers to reduce access disparities and ultimately improve urban quality of life for more residents.

6.1.3 Objective 3

Objective 3 examined disparities in green space access and evaluated the role of urban water infrastructure in improving access in an inner-city community in an industrialized nation. Analysis of the spatial distribution and diversity of green spaces between Tampa and East Tampa identified inequalities for East Tampa residents who have greater access to smaller, unconventional, and less desirable green spaces. Despite having significantly less available green space, East Tampa residents were found to have greater overall access than Tampa residents as a result of higher density development and greater access to public transportation.

Improving access to desirable green spaces within a walkable access distance was evaluated through the revitalization of unconventional green spaces using three development scenarios. These scenarios demonstrated the ability to improve green space access equality by enhancing urban water infrastructures (i.e., stormwater ponds) as multi-functional spaces that provide social and environmental amenities. The enhancement of these unconventional spaces was also highlighted as a way to reshape how urban residents view and contribute to urban water management, which includes watershed protection and water reuse.

In addition to environmental justice issues (i.e., disparities in traditional green space availability and diversity) within East Tampa, this lower-income, higher-density community also has lower levels of vegetation and tree coverage compared to other areas within the City of Tampa. Therefore, while it may not be feasible (or financially viable) to create new spaces or revitalize existing unconventional spaces, urban planners (in collaboration with community groups) could creatively add green spaces through the greening of railway lines, transportation corridors, and parking areas (Gill et al., 2007). Besides facilitating decentralized water management, a greener urban environment could promote a variety of social benefits such as reduced crime, increased social cohesion, and reduced health disparities by providing a “greener” urban environment (de Vries et al., 2003). However, to enhance decentralized stormwater management, new green spaces need to be hydrologically connected rather than islands disconnected by tall curbs, etc.

While the outcomes of this research promote a more holistic integration of land use and water management through the enhancement of existing urban water infrastructure to improve quality of life and the functioning of natural systems within urban environments; significant gains could also be made in new developments, as well as with the scheduled replacement of aged infrastructure, by designing and operating these grey infrastructures as multi-functional spaces that mimic natural systems.

6.1.4 Objective 4

Objective 4 analyzed the impacts of the following stressors on urban hydrology in a developing world city at a regional scale – urbanization, population growth, and reduced green space coverage. The application of a regional water balance model examined the impacts of spatial alterations due to land use change and temporal changes due to climate change in Santa Cruz. Examining the aridity index (potential evapotranspiration over precipitation) found a historical decreasing trend between 1970 and 2010, with increasing trends from 2011 to 2050 for all three IPCC emission scenarios. Although not unique to Santa Cruz, this shift in regional hydroclimatology indicates less humid future conditions, with potential negative impacts for water resources and natural ecosystems. It was determined that both climate change and land use changes have significant potential to impact the water balance, with extensive land use changes (i.e., increases in impervious surfaces) having the greatest impact on groundwater resources. At a regional level, the impacts of urbanization may compound impacts from agricultural developments that have already caused extensive deforestation in the Department of Santa Cruz.

Findings from this research expanded on the social and environmental importance of permeable green space, particularly for the urban poor who not only rely on these spaces for recreational and leisure pursuits, but also, because of a lack of basic services in peri-urban developments, for stormwater management and flood control, dilution of urban-derived recharge, and groundwater recharge. Collectively these benefits provide climate adaptations, which could be improved by systematically incorporating these spaces as a component of the urban expansion. Significant hydrological and societal benefits could be obtained by holistically integrating existing natural systems (i.e., wetlands and open space) with engineered stormwater infrastructure. However, this requires the valuation and protection of these natural systems, which in turn requires political leadership and education, as well as a systems thinking approach to development.

Furthermore, green spaces greater than 1 hectare (i.e., more than half of the green spaces included in the systematic observations from Chapter 3) can produce a cooler microclimate, with considerable contributions by mature trees for both shade and the interception of precipitation (Gill et al., 2007). Unfortunately, settlements in the peri-urban areas rarely protect natural vegetation and as a result, the urban poor tend to live in areas with lower tree and vegetation coverage. Therefore, future development should focus on conserving existing green space and natural features, while also utilizing opportunities to enhance vegetative cover in new developments. Urban planners must consider that once these spaces are developed or severely degraded (e.g., using wetlands as illegal dumps), they are difficult to redevelopment or replace.

At the local or regional level, Santa Cruz has less control over future climate changes due to the fact that Bolivia is a less developed country and has relatively low greenhouse gas emissions. Therefore, based on the potential hydrological impacts observed in the model simulations, urban planners and engineers should focus on modifying land use practices to limit development in sensitive recharge areas, incorporate natural systems as part of the stormwater management approach, and conserve green space (and natural vegetation) in new developments. These policy recommendations would help mitigate future negative impacts on urban hydrology while also reducing development related disparities in the peri-urban areas.

6.2 Recommendations

Drawing on conclusions from Chapters 2-5, the following recommendations are made.

6.2.1 Interdisciplinary Research

The world is becoming increasingly complex with urbanization being an important and increasing global stressor on environmental and human systems. Therefore, in order to develop innovative global solutions, engineers must broaden their design scope to incorporate social, environmental, and economic factors. Interdisciplinary research allows engineers to "think outside the box" by developing a dialogue with stakeholders and other researchers who can create an awareness of different design parameters than are not typically considered in a traditional engineering approach. This helps facilitate a more holistic design that can address multiple needs with the same, or fewer resources. In the end, it is important for our designs to mimic natural systems where every output is an input for a different component. Thus, in heavily modified urban landscapes, green spaces and water infrastructures should be designed in a way that restores the functions and benefits of lost or degraded natural ecosystems. Additionally, proper implementation of these urban amenities at the regional- or city-level could reduce the need to expand urban infrastructures such as drainage canals and grey water systems. This has important implications for the urban poor who often face considerable environmental and social injustices in many rapidly growing cities.

6.2.2 Re-Evaluation of Development Patterns: Integrating Systems

Engineers have an important role in improving the sustainability of our built environments and they must build on the understanding that the whole is greater than the sum of its parts. This requires a re-evaluation of our current development patterns, which are commonly approached in a piecemeal fashion that is inefficient in terms of resource allocation, land consumption, and quality of life. Often decisions are made that result in short-term solutions at the expense of long-term resource availability. This has become increasingly apparent in rapidly developing cities, in both the developed and developing world. In the case of Santa Cruz, this is illustrated by the municipality's short-term solution to flooding, which is namely filling in wetlands and developing an expansive concrete drainage canal network, at the long-term expense of groundwater recharge and ultimately, reduced water quality.

This flooding and water quality example from Santa Cruz highlights the connection between environmental, social, and economic issues as well as the relationship between land use decisions and hydrological impacts, and vice-versa. Therefore, it is important to integrate traditionally separate systems such as water management, transportation networks, and urban development. Integrated, systems-thinking approaches are essential to sustainable development and engineers must consider the broader social and environmental functions of their designs and not only work within economic constraints. Thus future stormwater management in Tampa, or in other cities relying on stormwater ponds, should incorporate a more integrated approach that utilizes multi-functional urban water infrastructures that provide social benefits and improve environmental services. Ultimately, this research challenges engineers to collaboratively partner with other disciplines such as architecture, urban planning, public policy, ecology, and public health as well as community members in order to develop more innovative and sustainable solutions.

6.2.3 The Value of Unconventional or Degraded Spaces

Re-evaluating urban landscapes and development patterns is an important step toward reshaping our views in how we design and use engineered infrastructures and urban amenities. Historically there has been little need to efficiently use undeveloped green spaces and even less to reuse degraded urban areas. However, many unconventional spaces represent under-utilized potential and are often located in environmentally sensitive areas (i.e., along waterfronts) or in traditionally disenfranchised communities. As we continue to place more demands on finite resources, the revitalization of these spaces offers an alternative development pattern than the current business-as-usual scenario. This could also enhance the resiliency of communities and economies, while helping to preserve open spaces near urban centers, which provide essential functions such as air purification, stormwater management, and groundwater recharge.

Based on this research, it is recommended that communities inventory their existing amenities such as open spaces, parks, water features, as well as potential amenities including degraded spaces and brownfields. This is not only a first step towards more sustainable land use because it allows for enlightened management of existing resources, but it also enables more holistic urban planning that can protect sensitive areas that may be important for environmental or social purposes. Involving residents in the process also encourages community ownership, which is essential for maintaining green spaces, protecting water resources, and enabling brownfields redevelopment.

6.3 Future Research

A variety of methods can be used to quantify the impacts of urbanization on green space and water resources; however, limitations based on time and/or data availability often determine the extent of these analyses. Therefore, the specific research outlined in this dissertation would benefit from the following future work:

1. Improved land use data in the city of Santa Cruz would allow for a more detailed spatial analysis of green space coverage to be conducted. This information could be used to inform policy makers, engineers, and urban planners regarding the protection of sensitive groundwater recharge areas, the placement of future residential development, and the location of future large urban parks. Currently, decisions regarding the designation of green spaces are made at the district or neighborhood unit (UV) level, which does not allow for the utilization of a holistic planning framework.

2. More research is needed to fully understand the issue of green space accessibility versus usability in Tampa. This could include a network analysis to account for actual travel distances and patterns as well as an evaluation of green space quality and congestion. This could also include the classification of existing stormwater ponds based on physical structure and ability to be revitalized (i.e., location to residential areas, community acceptance, estimated costs).
3. Hydrological analyses were limited to a specific type of modeling approach because of a lack of available data in Santa Cruz. Further research should focus on obtaining additional streamflow data for both the Pirai River the Grande River as well as groundwater level data for the city of Santa Cruz. This would provide the necessary data for increasingly complex hydrological models as well as allow for a better approximation of future hydrological conditions. Thus improving estimations of potential impacts of land use decisions and water withdrawals.
4. Data obtained from the water balance model could also be linked with a water quality model to provide a complete hydrological analysis in Santa Cruz. Currently the city is dealing with decreasing water quality and quantity. Therefore, this would provide improved knowledge of the groundwater system and could assist with land use planning at the city level.

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Appendices

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Appendix B: Chapter 3 Supplemental Information

B.1 Green Space Interview Questions

B.1.1 English Version

1. How frequently do you use this area? On the weekends? During the week?
    a. What distance is it from your house?
    b. What type of transport do you utilize – walk, bike, bus, car?
        i. How long does it take you to get to these areas?
    c. Do you usually go by yourself or with others?
2. Is there anything that limits how often you use this area or other similar areas?
3. What do you like or dislike about this area?
4. Are there any other areas where you go to relax, visit with friends or recreate?
    a. Could you describe these areas?
        i. What types of activities are there?
        ii. Is there equipment? For kids? For youth? For adults?
        iii. What size are these areas?
    b. What do you use or do in these areas?
5. Are there other areas that your family, friends, or neighbors use but you don't?
    a. Why do you not use these areas?
6. Can you describe any benefits of these areas for your health? Your neighborhood or city? The environment?
7. Do you think there are enough areas like these in your neighborhood? In your district? In the city?
8. Are there natural areas (with plants, trees, etc) in your neighborhood?
    a. Do you use them? Do other people use them?
    b. How are they used?
    c. Are there benefits or problems with these types of areas?

Appendix B (Continued)

B.1.2 Spanish Version

1. ¿Con que frecuencia usa esa área? ¿Los fines de semanas? ¿Todos los días?
    a. ¿Cuánto distancia es desde su casa?
    b. ¿Qué tipo de transporte utiliza – por pie, por bicicleta, por micro, por coche?
        i. ¿Cuántos minutos para llegar en estas áreas?
    c. ¿Usualmente va solo o con otros?
2. ¿Hay cualquiera razón que limite la frecuencia que usa usted esa área u otras similares áreas?
3. ¿Qué le gusta o no le gusta sobre esa área?
4. ¿Hay cualquiera otras áreas donde va usted para relajar, alternar con amigos, o recrear?
    a. ¿Pudiera describir estas áreas?
        i. ¿Qué tipos de actividades están?
        ii. ¿Está equipamiento? ¿Para los niños? ¿Para los jóvenes? ¿Para los adultos?
        iii. ¿Qué es el tamaño de las áreas?
    b. ¿Qué usa o hace usted in estas áreas?
5. ¿Hay otras áreas se usan por su familia, amigos, o vecinos, pero usted no los usa?
    a. ¿Por qué no va? ¿Hay algo que no le gusta?
6. ¿Pudiera describir cualquieras beneficios de las áreas para su salud? ¿Su vecindario o ciudad? ¿El medio ambiental?
7. ¿Piense usted que hay bastante áreas como estos en su vecindario? ¿En su barrio? ¿En la ciudad?
8. ¿Hay áreas naturales (con plantas, arboles, etc.) en su barrio?
    a. ¿Usted usa? ¿La gente usa?
    b. ¿Cómo están usado?
    c. ¿Hay beneficios o problemas con estos tipos de áreas?

Appendix B (Continued)

Table B1. Green space questions, Interviewees 1 through 24.

Interview #	Green Space Type	Green Space Location	Age	Gender	Income	Use frequency	Transport	Travel Time	House Location
1	LUP	Inner district	20	M	mid	Irregular	micro	5	Inner district
2	LUP	Inner district	50	M	mid-low	never	micro	30	Outer district
3	LUP	Inner district	30	F	mid-low	never	micro	30	Outer district
4	LUP	Inner district	18	F	mid	Intermittent	micro	30	Outer district
5	LUP	Inner district	18	F	mid	Intermittent	micro	30	Outer district
6	LUP	Inner district	40	M	mid	never	taxi		Outer district
7	LUP	Outer district	30	M	mid	Intermittent	car	5	Inner district
8	LUP	Outer district	20	M	mid-upper	Regular	car	10	Inner district
9	LUP	Outer district	20	F	mid-upper	Regular	car	10	Inner district
10	LUP	Outer district	30	family	mid	Regular	car	5	Inner district
11	LUP	Outer district	20	F	mid	Frequent	car	15	Inner district
12	LUP	Outer district	20	F	mid	Irregular	car	60	Outer district
13	LUP	Outer district	30	family	mid	Irregular	car	60	Outside of city
14	LUP	Outer district	50	M	mid	Regular	car	15	Inner district
15	LUP	Outer district	30	M	mid	Regular	car	10	Inner district
16	LUP	Outer district	30	F	mid	Regular	car	5	Inner district
17	LUP	Outer district	20	F	mid	Intermittent	micro	60	Outer district
18	LUP	Outer district	50	F	low	Irregular	micro	60	Outer district
19	LUP	Outer district	50	F	mid	Irregular	micro	60	Outer district
20	LUP	Outer district	30	F	mid	Irregular	micro	30	Outer district
21	LUP	Outer district	20	M	mid-upper	Intermittent	motorcycle	45	Outer district
22	LUP	Outer district	30	F	mid	Intermittent	taxi	15	Inner district
23	LUP	Outer district	30	F	mid	Intermittent	taxi	15	Inner district
24	LUP	Outer district	30	M	mid	Irregular	taxi	5	Inner district

Appendix B (Continued)

Table B1. (Continued)

#	How use	Likes	Dislikes
1	alone	Place to think; likes water and vegetation/trees	
2			Fence
3			Safety record of Parque Arenal
4	socially		
5	socially		
6	alone		Dangers and annoyances of GS and public space
7	socially	Shade, place for kids to play	None
8	socially	Bigger size, atmosphere, social gathering sites	
9	socially	Bigger size, atmosphere, social gathering sites	
10	socially	Likes atmosphere	None
11	socially	Trees, shade, safety, more people (safety)	People bringing pets (makes mess)
12	socially	Calm	
13	socially	Likes visibility to see kids (spread out trees)	None
14	socially	Relaxing atmosphere	
15	socially		
16	socially	Near home	
17	socially	Safe	GS are small and less safe near home
18	socially		
19	socially		
20	socially	Safe	GS are small and less safe near home
21	socially	Families playing	GS are small and less safe near home
22	socially	Bigger size, shade, safety	None
23	socially	Celebrate special occasions; kids can ride bikes	
24	socially	Safe, fenced, places to cook, kids can ride bikes	Needs phones for safety

Appendix B (Continued)

Table B1. (Continued)

#	**Meaning of Green Space?**	**Barriers**	**Benefits**
1	Protected areas for wildlife & vegetation	Distance	Get to know wildlife, learn more about country
2		Safety, annoyance of crime	None
3		Safety	Open space and place for children to play
4			Place to relax
5			Place to relax
6		Safety, lack of parks	
7			Place to relax and let kids play
8			Place to be with family and relax
9			Place to be with family and relax
10			Place to relax, enjoy fresh air and let kids play
11			Safe place to recreate, place to enjoy fresh air and nature
12			Place to relax and hang out (friends and family)
13		Distance	Place to relax and let kids play
14			Relax, shade, fresh air, vegetation/trees
15			Place to relax and let kids play
16			Place to be with family
17		Safety and size of small parks	Shade, vegetation/trees, relax
18		Distance, time	Shade, large space
19			Place to celebrate special occasions
20		Safety and size of small parks	
21			Place to be with family/significant other
22			Safe and large place to recreate
23			Place to hang out and let kids play
24			Shade, vegetation, social gather sites

Appendix B (Continued)

Table B1. (Continued)

#	Enough Green Spaces?	Notes/Additional Comments
1		Lives near Chilean border; Nature is more dangerous in Bolivia
2		Vender outside of park
3	No	Vender outside of park
4		Use park when coming to center for market (Los Pozos)
5		Use when come to center
6	No, not enough in neighborhood or city	Cab driver working near park
7		Family of 5
8	No	First time came to park to cook
9	No	First time came to park to cook
10		Use smaller parks (variety of parks) near home frequently
11		Family of 5
12		
13	No	From campo, foreigners (missionaries?)
14		Visits other LUPs; multi-generational family (12)
15		
16		
17		
18	No	Indigenous, multi-generational family
19	No	
20		
21		
22	Only smaller parks near home	Multi-generational family; smaller parks were considered less usable
23		Park is near home
24	No, not big enough	Came with family of 6, used taxi to bring bikes

Appendix B (Continued)

Table B2. Green space questions, Interviewees 25 through 44.

Interview #	Green Space Type	Green Space Location	Age	Gender	Income	Use frequency	Transport	Travel Time	House Location
25	LUP	Inner district	20	M	mid	Regular	car	5	Inner district
26	LUP	Inner district	20	F	mid	Frequent	micro	30	Outer district
27	LUP	Inner district	18	F	mid	Frequent	micro	10	Inner district
28	LUP	Inner district	20	F	mid-low	Irregular	micro	10	Inner district
29	LUP	Inner district	40	F	mid	Intermittent	micro	30	Outer district
30	LUP	Inner district	20	F	mid	Intermittent	micro	30	Outer district
31	LUP	Inner district	30	M	mid-low	Intermittent	micro	30	Outer district
32	LUP	Inner district	30	F	mid-upper	Intermittent	taxi	10	Inner district
33	LUP	Inner district	30	M	mid	Frequent	walk	5	Inner district
34	LUP	Inner district	50	M	mid	Frequent	walk	10	Inner district
35	LUP	Inner district	20	F	mid-upper	Frequent	walk	5	Inner district
36	LUP	Inner district	20	F	mid	Frequent	walk	5	Inner district
37	LUP	Inner district	20	M	mid	Irregular	walk	5	Outside of city
38	LUP	Inner district	30	F	mid	Intermittent			Outside of city
39	LUP	Outer district	30	F	mid-low	Frequent	micro	20	Inner district
40	LUP	Outer district	20	F	mid	Frequent	walk	2	Outer district
41	SNP	Inner district	50	M	mid-low	Frequent	micro	30	Outer district
42	SNP	Inner district	30	F	mid	Irregular	micro	30	Outer district
43	SNP	Inner district	20	F	mid	Irregular	micro	7.5	Inner district
44	SNP	Inner district	60	F	mid	Irregular	micro	90	Outer district

Appendix B (Continued)

Table B2. (Continued)

#	How use	Likes	Dislikes
25	socially	Near restaurants	
26	socially	Can bring kids	
27	socially		Unsafe areas/parks (i.e., Arenal near Los Pozos)
28	socially	LUPs	
29	socially	Take breaks from work	
30	socially	People watch and look from tower; chess boards	
31	socially		Dirtiness
32	socially	Kids can play; traditional gather place	Not secure
33	alone	LUPs	
34	socially	Meeting place	
35	socially	Visit after class	When there are not many park users
36	socially		Unsafe when few people are around
37	socially	Near hotel	
38	socially	Get to know a new place	
39	work	Taking care of plants	Don't have nice flowers in this park because get stolen
40	socially	Workout & play equipment; lit, guards until 10; well-maintained	Need a cancha
41	alone		Only canchas near his home
42	socially	Nice place to take visitors	
43	socially		Lack guards and light
44	socially	Offers distraction, somewhere new	Needs more equipment & amenities and better access for elderly

Appendix B (Continued)

Table B2. (Continued)

#	Meaning of Green Space?	Barriers	Benefits
25			Place to relax and socialize
26			Place to relax, get out of the house, and let kids play
27	Places to share	Safety, reputation of some parks	Places to socialize
28	Places we need (and more of); a place to care for	Safety and lack of park variety	Place to relax and let kids play
29		Time, safety	Place to relax
30		Safety	Place to relax and socialize
31	Shared space	Safety, unkept/dirty	Places to socialize and relax
32			Place to socialize and let kids play
33			Place to relax and socialize
34	Spaces for trees and for people to enjoy	Safety (for women)	Place to relax and socialize
35		Safety and time	Place to relax, socialize, get out of the house
36		Safety	Places to socialize
37			Place to socialize
38			Place to socialize and get to know a new place
39			Place to socialize and let kids play
40			Place to recreate and let kids play
41			Place for kids to play
42			Offers distraction and place to relax
43		Safety	Place for kids to play
44		Time	Place to go to get out of house and associated stress from daily life

Appendix B (Continued)

Table B2. (Continued)

#	Enough Green Spaces?	Notes/Additional Comments
25		
26		Feels safe using parks alone and with kids. Men and women seek different ambiance than what they find/experience at home. Parks let kids get out of women's hair and men feel more free than women, who typically have more household responsibilities (so cannot use parks as much)
27	No, not enough in neighborhood or city	
28	No	GS near home is canchas, and only males use them
29		"Everyone has their own particular way to relax; in their own way, at their own convenience, because we all have different tastes"
30	Small parks near home, but only boys use canchas; occasionally uses small plazas	Men become a nuisance when you are using a park alone; "when there are guards, there is no fear"
31		Says need more people to take care of parks, people don't respect public spaces/GS
32		
33		Uses after work and on breaks; also uses parks with friends and family
34		
35		Safety issues are a reality for all people in the city - affects foreigners and locals alike
36		Fewer people use parks in winter, so less safe then
37		Visiting from within Department of SC
38		From colombia on vacation
39	No parks near home	Works as a gardener
40		
41	No - NBHD	Indigenous; Sells ice cream by a school in different district
42		
43	No - parks near home are not safe	Likes park because has a fountain
44	No	Multi-generational family of women

Appendix B (Continued)

Table B3. Green space questions, Interviewees 45 through 68.

Interview #	Green Space Type	Green Space Location	Age	Gender	Income	Use frequency	Transport	Travel Time	House Location
45	SNP	Inner district	30	F	mid	Irregular	micro	90	outside of SC
46	SNP	Inner district	30	F	mid	Intermittent	micro	30	Outer district
47	SNP	Inner district	18	M	mid	Regular	micro	60	Outer district
48	SNP	Inner district	40	family	mid	Irregular	taxi	20	Inner district
49	SNP	Inner district	20	M	mid	Frequent	walk	5	Inner district
50	SNP	Inner district	20	F	mid	Frequent	walk	5	Inner district
51	SNP	Inner district	20	M	mid	Frequent	walk	5	Inner district
52	SNP	Inner district	20	F	mid	Frequent	walk	5	Inner district
53	SNP	Inner district	30	F	mid	never	walk	-	Outer district
54	SNP	Inner district	30	F	mid	Regular	walk	2	Inner district
55	SNP	Outer district	30	M	mid	Frequent	walk	2	Outer district
56	SNP	Outer district	30	F	mid	Frequent	walk	2	Outer district
57	SNP	Outer district	30	F	mid	Frequent	walk	2	Outer district
58	SNP	Outer district	20	M	mid-low	Frequent	walk	2	Outer district
59	SNP	Outer district	18	M	mid	Intermittent	walk	1	Outer district
60	SNP	Outer district	30	F	mid	Intermittent	walk	1	Outer district
61	SNP	Outer district	40	M	mid	Intermittent	walk	5	Outer district
62	SNP	Outer district	30	M	mid	Intermittent	walk	1	Outer district
63	LUP	Outer district	20	M	mid	Frequent	micro		
64	LUP	Outer district	18	F	mid-low	Irregular	micro	30	Outer district
65	LUP	Outer district	40	F	mid-low	Irregular	micro	45	Outer district
66	LUP	Outer district	40	F	mid-low	Irregular	micro	15	Inner district
67	LUP	Outer district	18	F	mid-low	Intermittent	micro	30	Outer district
68	LUP	Outer district	20	F	mid-low	Regular	micro	30	Outer district

Appendix B (Continued)

Table B3. (Continued)

#	How use	Likes	Dislikes
45	socially	Free	
46	socially		None
47	socially	Place to play soccer	Trees block light makig it unsafe
48	socially	Few cars in area (safety for kids playing on cancha)	
49	socially		Drunks at night
50	socially		Drunks at night
51	socially	To walk through	Mostly used by school kids
52	socially	Walk with boyfriend	
53		Lives close	Dangers associated with park
54	socially	Location and stuff for kids	Sometimes dirty
55	socially	Play equipment	Drunks in park
56	socially	Play equipment	Could be safer and cleaner
57	socially	Cancha for kids, calm, nice	
58	socially	Near where working	
59	socially		
60	socially	Social events	
61	alone	Play equipment, ball field	
62	socially		Robbers
63	work	Big park, near schools	People do bad things, gangs at night
64	socially	Parque Urbano	Adolescents/drug users
65	socially		
66	socially		
67	socially	Meet friends, hang out, bigger spaces	
68	socially	Social areas	

Appendix B (Continued)

Table B3. (Continued)

#	Meaning of Green Space?	Barriers	Benefits
45			Place to socialize and get out of the house
46		Safety, size of park	Place to be with family
47	Places for young people, places for fun	Safety	Place to recreate
48			Place for kids to play
49			Place to socialize and relax
50			Place to socialize and relax
51		Safety	Place to socialize and recreate
52		Safety	Place to socialize and recreate
53		Safety	-
54		Time	Place for kids to play
55			Place for kids to play
56			Place for families and kids
57			Place to relax and let kids play
58			Place to relax and recreate
59			Place to recreate and socialize
60	Park		Place to enjoy fresh air and shade; place for kids to play
61			Place for families and kids
62		Safety	Place for kids/young people to play
63	Places with no owners		Place to socialize and let kids play
64		Safety	Place to socialize
65		Time	Place to relax
66		Time	Place to relax outside of house
67			Place to socialize
68		Time	Place to relax

Appendix B (Continued)

Table B3. (Continued)

#	Enough Green Spaces?	Notes/Additional Comments
45		From CBBA visiting family
46	No - parks near home are not safe	
47		
48		
49		Canchas are used primarily by schools and kids for soccer, but not used otherwise
50		
51		
52		
53		Works near park
54		Only visits this park (right near house)
55		Works near park
56		Works near park
57		Cancha mostly used by kids
58		Workers taking a break (during or after work)
59		Family has shop across from park
60		Shop across from park
61		Works near park
62		Works near park
63		Has water feature
64	No	Does not consider canchas GS/parks; parks feel safer when there are more people, specifically more families and older people (not just adolescents who may be using drugs)
65		When has time to relax, usually late by time gets home, so rarely gets to go
66	Yes - in center	
67	No	There are small plazas near her house, but nobody uses them
68		Uses parks on weekends when not working

Appendix B (Continued)

Table B4. Green space questions, Interviewees 69 through 90.

Interview #	Green Space Type	Green Space Location	Age	Gender	Income	Use frequency	Transport	Travel Time	House Location
69	LUP	Outer district	40	M	mid-low	never			Outer district
70	LUP	Outer district	18	M	mid	Regular	micro	30	Outer district
71	LUP	Outer district	20	M	mid	Frequent	micro		
72	LUP	Outer district	30	F	low	Irregular	micro	120	Outside of city
73	LUP	Outer district	18	F	mid	Frequent	taxi	5	Outer district
74	LUP	Outer district	20	F	mid-low	Frequent	walk	5	Outer district
75	LUP	Outer district	30	M	mid-low	Frequent	walk	1	Outer district
76	LUP	Outer district	30	F	mid-low	Frequent	walk	1	Outer district
77	LUP	Outer district	20	M	mid-low	Frequent	walk	5	Outer district
78	LUP	Outer district	20	M	mid-low	Frequent	walk	5	Outer district
79	LUP	Outer district	50	F	low	Frequent	walk	1	Outer district
80	LUP	Outer district	18	F	mid	Intermittent	walk	5	Outer district
81	LUP	Outer district	30	family	mid	Frequent	micro	5	Outer district
82	LUP	Outer district	18	M	mid	Frequent	walk	1	Outer district
83	LUP	Outer district	18	F	mid	Frequent	walk	5	Outer district
84	LUP	Outer district	18	M	mid	Regular	walk	10	Outer district
85	LUP	Outer district	18	F	mid	Regular	walk	10	Outer district
86	LUP	Inner district	20	M	mid	Frequent	car	7	Inner district
87	LUP	Inner district	20	M	mid	Irregular	car	60	Outside of city
88	LUP	Inner district	20	F	mid	Irregular	car	60	Outside of city
89	LUP	Inner district	20	F	mid	Intermittent	car	10	Inner district
90	LUP	Inner district	30	family	mid	Regular	micro	60	Outer district

Appendix B (Continued)

Table B4. (Continued)

#	How use	Likes	Dislikes
69	-	Would like to be able to use parks	
70	socially		
71	work	Very safe, park users are respectful	
72	socially	Kids can play and rest	
73	socially	clean	
74	socially	Chess tables, ambience	
75	socially		
76	socially		None
77	socially		
78	socially	Chess tables, ambience	
79	socially	Gardens, playground equipment, near home	Things in disrepair
80	socially		Only canchas in area, and not many
81	socially	Rent bikes for kids	Not fenced in, needs more guards
82	socially	Calm	Not safe after 9, go somewhere else
83	alone	People learning to dance	Needs more guards
84	socially	Exercising	Not secure when less people around; needs better care of plants and trees
85	socially	Larger parks/plazas	Not secure after 9 pm
86	socially	Relaxing, calm	
87	socially	Place to get out of car (on road trip)	
88	socially	Place to get out of car (on road trip)	
89	socially		Unsecure parts were guards don't go
90	socially	Bigger space, walking around, kids can play	Side with more trash and less people (older park)

Appendix B (Continued)

Table B4. (Continued)

#	Meaning of Green Space?	Barriers	Benefits
69		Time	Place to relax and be with family
70			
71			Place to relax, get fresh air, and let kids play
72		Distance	Place for kids to play and relax
73		Safety at night, distance	Place to relax
74		None	Place to socialize and relax
75			Place to relax
76			Place to socialize and relax
77			Place to socialize and enjoy fresh air
78		None	Place to socialize and relax
79			Place to relax and let kids play
80			Place to socialize
81		Safety	Place to relax and let kids play
82		Safety	Place to relax and socialize
83		Safety	Place to socialize
84		Safety	Place to socialize and recreate
85		Safety	Place to relax
86			Place to relax and get away from house
87			Place to relax
88			Place to relax
89			Place to relax
90			Place to relax, recreate

Appendix B (Continued)

Table B4. (Continued)

#	Enough Green Spaces?	Notes/Additional Comments
69		Works 12 hours a day and with family obligations has no time to use parks, but would like to
70		
71		Works in park
72	No	Indigenous woman with 5 young kids
73		Use NBHD parks on Sat & nights
74		Live near park and play with stones, rather than real chess pieces
75		Also use Urbano
76		Also use Urbano
77		Group of 2 young indigenous couples
78		Live near park and play with stones, rather than real chess pieces
79		Park run-down (trash, alcohol bottles, dead cat), but only complaint was broken playground equipment
80	No	
81		
82		
83		People leave at 10 when guards leave because not safe after
84		
85	No	Does not use canchas because doesn't play soccer (no other GS near home)
86		Does not uses plazas and canchas near home because wants to get away
87		
88		Not from Santa Cruz
89	No	
90	Smaller plazas near home, but less to see in them	

Appendix B (Continued)

Table B5. Green space questions, Interviewees 91 through 108.

Interview #	Green Space Type	Green Space Location	Age	Gender	Income	Use frequency	Transport	Travel Time	House Location
91	LUP	Inner district	20	M	mid-upper	Regular	micro	30	Outer district
92	LUP	Inner district	40	M	mid	Regular	micro	10	Outer district
93	LUP	Inner district	40	F	mid	Regular	micro	10	Outer district
94	LUP	Inner district	20	M	low	Frequent	micro	30	Outer district
95	LUP	Inner district	20	F	low	Frequent	micro	30	Outer district
96	LUP	Inner district	40	M	mid	Frequent	micro	30	Outer district
97	LUP	Inner district	20	M	mid	Intermittent	micro	135	Outside of city
98	LUP	Inner district	20	F	mid	Intermittent	micro	135	Outside of city
99	LUP	Inner district	20	F	mid-low	Intermittent	micro	10	Inner district
100	LUP	Inner district	20	family	mid	Regular	micro	120	Outside of city
101	LUP	Inner district	18	F	mid	Regular	micro	150	Outer district
102	LUP	Inner district	40	M	mid	Regular	micro	60	Outer district
103	LUP	Inner district	20	M	mid	Irregular	taxi	10	Inner district
104	LUP	Inner district	30	M	mid	Intermittent	taxi	10	Inner district
105	LUP	Inner district	40	F	mid	Intermittent	taxi	20	Outer district
106	LUP	Inner district	30	F	mid	Intermittent	taxi	20	Outer district
107	LUP	Inner district	30	F	mid	Frequent	walk	5	Outer district
108	LUP	Inner district	20	F	mid-upper	Regular	walk	5	Inner district

Appendix B (Continued)

Table B5. (Continued)

#	How use	Likes	Dislikes
91	socially	Shade and fresh air, get out of hot house	
92	socially	Bigger space, vegetation/trees	Parks with less vegetation
93	socially	Bigger space, vegetation/trees	Parks with less vegetation
94	socially		
95	socially		
96	alone	Shade, place to relax after work	
97	socially	Get out of house, hang out with friends/significant other	
98	socially	Get out of house, hang out with friends/significant other	
99	socially	Nice park, lots of amenities	None
100	socially	Bigger space	
101	socially	Calm and more fun	
102	socially	Rest after work before goes home	
103	socially	Calm and enclosed	
104	socially	Calm	
105	socially	Bigger space	Small green spaces
106	socially	Fountain is tranquil	
107	socially	Place to visit with boyfriend, enjoys trees/vegetation	
108	socially	Place to visit with boyfriend	

Appendix B (Continued)

Table B5. (Continued)

#	Meaning of Green Space?	Barriers	Benefits
91			Place to enjoy fresh air, get out of hot house
92			Place to enjoy fresh air, get out of hot house, place to relax
93			Place to enjoy fresh air, get out of hot house, place to relax
94			Place to relax
95			Place to relax
96			Place to relax, enjoy shade and fresh air
97			Place to play and hang out
98			Place to play and hang out
99			Place for kids to play
100		Distance, time	Place to relax and let kids play
101		Distance, time	Place to relax and let kids play
102			Place to relax
103			Place to relax
104	Canchas, city takes care of, near schools		Place to relax
105		Distance	Place to relax and let kids play
106			Place to relax, socialize
107	Evokes desire to protect, care for, and respect nature and public spaces		Place to enjoy fresh air, vegetation, and let her kid play
108			Place to enjoy fresh air, get out of hot house, place to relax

Appendix B (Continued)

Table B5. (Continued)

#	Enough Green Spaces?	Notes/Additional Comments
91		
92		Like because biggest park and has lots of vegetation
93		Like because biggest park and has lots of vegetation
94		Had bottle of liquor in park
95		Had bottle of liquor in park
96		Lives far away and uses park before heads home from work
97		
98		
99		Nanny with small boy, heard park was nice so came
100	No	Only small parks near home
101	No	Nanny watching 2 kids
102		Met up with a woman after interview
103		
104		
105	No - only canchas and small plazas near home	
106	No	Came specifically to see water fountain - it is tranquil
107		Lives far away but works near park, so uses after work
108		

Appendix C: Improving Urban Quality of Life by Enhancing Access to Unconventional Green Spaces and Water Infrastructure[3]

C.1 Introduction

Currently more than half of the world's population resides in cities, and by 2050 that number is expected to increase to over 70% (UN-HABITAT, 2008). Population growth is associated with dynamic changes around the world that are causing a variety of environmental, social, and economic problems. Some of these changes include exponential growth in urbanization, water consumption, vehicle usage, land conversion, species extinction, and resource utilization (Zimmerman et al., 2008). Furthermore, much of this population growth is occurring in cities located in environmentally sensitive coastal areas, where population densities can be twice the global average (UNEP, 2005). All of this has lead to greater complexity in the planning of cities for use by current and future generations.

Collectively these stressors have placed greater demands on ecosystems, particularly water resources. Yet within urban areas, natural spaces and water features are often under-valued, leading to their degradation or destruction. Additionally, natural ecosystems located in less densely populated areas have often been the focus of protection efforts with less interest in protecting urban green spaces (Arambiza & Painter, 2006). Yet green spaces and water features, including both modified and natural spaces, provide numerous social, environmental, and economic benefits within the urban landscape. These include stormwater management, pollutant filtration, microclimate regulation, wildlife habitat, and recreational opportunities (Bolund & Hunhammar, 1999). The integration of these natural systems with built infrastructure represents a new paradigm for managing urban water resources more sustainably and holistically, while also providing enhanced social and environmental amenities (Boyle et al., 2010).

Green space includes natural or human-modified outdoor spaces, either publicly or privately owned, that are comprised of significant amounts of vegetation, water, and/or permeable surfaces (Budruk and Tyrrell, 2009). Table C1 lists several attributes of green space related to water. This table highlights the importance of integrating green space into urban planning. Recent research also demonstrates that urban residents residing in areas with more green space may be significantly healthier than those living in environments with less green space (de Vries et al., 2003), with the presence of water being found to create even greater benefits. For example, people exercising in natural environments with the presence of water experienced greater enhanced self-esteem and mood (Barton & Pretty, 2010).

[3] This paper will be presented at the International Water Association Cities of the Future 2011 conference (and was submitted as a publication for the conference proceedings) (Wright Wendel et al., 2011a).

Appendix C (Continued)

Table C1. Attributes of green space that improve water management in urban areas.

Benefit
Facilitate hydrological processes in areas where urban development interferes with the movement, distribution, and quality of water
Provide social, health, environmental, and economic benefits to communities, such as increased levels of physical activity and enhanced community cohesion
Filtration of water pollution
Increased control of stormwater runoff and flooding, thus reducing system loadings
Enhanced groundwater recharge
Provision of wildlife habitat
Reduced need for pollution prevention measures

One approach to urban planning, in regards to providing populations with access to green space and water features, is through the integration of more sustainable "green" infrastructures with older, existing "grey" infrastructures. However, this integration requires a re-evaluation of engineered infrastructures and unconventional open spaces, within both a cultural and geographical context. As urban areas become more densely developed, planners, architects, engineers, and ecologists must work collaboratively to enhance the equity and sustainability of these urban amenities, thus providing greater resiliency and liveability of the cities of the future (UN-HABITAT, 2008).

Our previous work examined the link between issues of environmental justice and urban water management to evaluate potential improvements in green space and surface water access through the revitalization of existing engineered water infrastructures, namely stormwater ponds (Wright Wendel et al., 2011b). Here we perform a similar analysis of two distinct communities within our overall study area. The first community, East Tampa, is characterized by a lower-income and larger minority population who lack access to natural water features but have access to many engineered water infrastructures. The second community, South Tampa, has several large natural water features and is characterized by a higher-income and larger White population. Ultimately, the "greening" of grey urban water infrastructures is advocated as a way to address environmental injustices related to disparities in green space and water feature distribution and access while also reconnecting residents with issues of urban water management.

Appendix C (Continued)

C.2 Methods

As with many cities in Florida, the Tampa-Clearwater-St. Petersburg Metro area has rapidly developed over the past several decades due to its subtropical climate and abundance of natural water features. This area is characterized by humid, wet summers and dry, temperate winters, and uses stormwater drainage ponds to manage high summer flows. With increasingly scarce water resources, much of the population is beginning to learn how to face water shortages and more sustainably use this limited resource. Despite an abundance of natural water features within Tampa, private development has reduced public access along the Hillsborough River and Tampa Bay. As a result, some communities have become "landlocked" with limited or no access to these water resources.

Two distinct communities were selected for this research. East Tampa, the first community, is a "landlocked" inner-city community characterized by slum and blight conditions, such as high levels of crime, housing vacancy, deteriorating structures, and poverty (City of Tampa, 2003). Although this community has no natural water features within its boundaries, it has a relatively high quantity of unconventional green spaces (i.e., cemeteries and stormwater ponds). While the second community, South Tampa is bounded by Tampa Bay on two sides and the Hillsborough River on the east. Figure C1 shows the total area occupied by the city of Tampa, the two communities of East and South Tampa, and their relationship to major natural water features. Both communities developed around the same general time period and have relatively higher population densities (>4,000 residents per square mile) than other communities in Tampa. Despite these similarities, South Tampa is characterized as a higher-income, predominately White community, whereas East Tampa has a large minority, lower-income population. It was previously determined that East Tampa residents (relative to the whole city of Tampa) lack access to natural water features and traditional green spaces (Wright Wendel et al., 2011b); therefore, there was an interest in comparing this "landlocked" lower-income community with the "water-locked" higher income community of South Tampa. The methodology of this study was adapted from a previous study performed by Wright Wendel et al. (2011).

Appendix C (Continued)

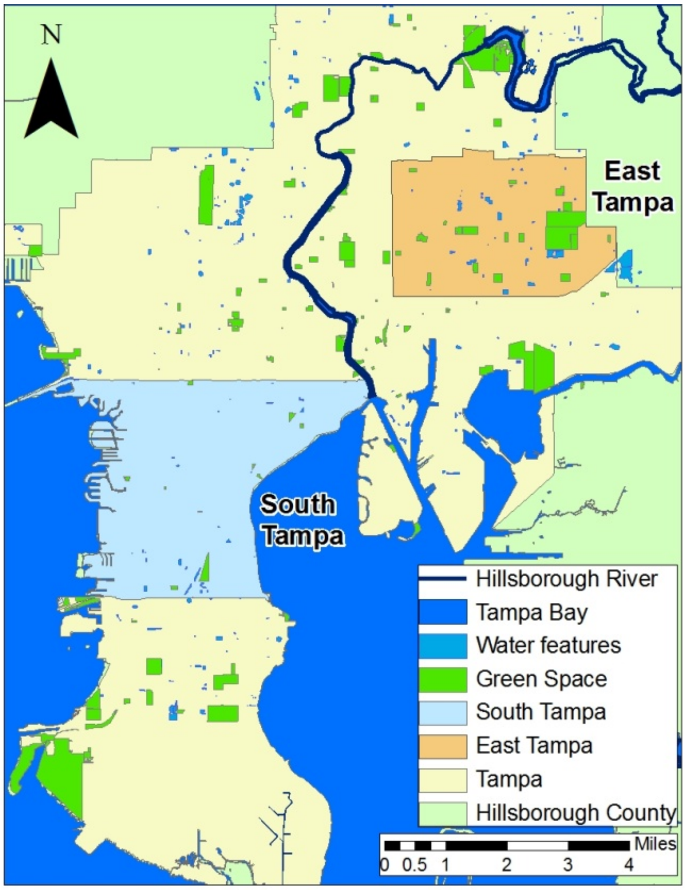

Figure C1. South Tampa and East Tampa (Florida) are highlighted within the city of Tampa, along with the location of green spaces and water features. These water features include natural water (Tampa Bay, Hillsborough River, lakes) and urban water infrastructures.

C.2.1 Defining Green Space

Green space can be either public or private, however, this study focused on public green space, which is free and available for all to use. It includes spaces such as parks, open space, surface water features, and cemeteries (Table C2). Water features consist of urban water infrastructure, namely stormwater ponds, and natural water, such as lakes, rivers, and bays. Table C2 provides a description of the different types of green space evaluated in this study, which were divided into three main categories based on amenities and physical characteristics: 1) Total *Public* green space; 2) *Traditional* green space, and 3) Green spaces with *Water* features, (City of Tampa, 2009b; Florida Geographic Data Library). Also provided in Table C2 are the maximum distances for which community members are expected to travel to access a particular type of green space.

Appendix C (Continued)

Table C2. Description of the three main categories of green space (Public, Traditional, and Water), including sub-types, and the corresponding access distances (Wright Wendel et al., 2011b).

Type of Green Space		**Description**	**Access Distance**
Public	Traditional	Parks, playgrounds, recreation facilities, open space	400 m
	Unconventional	Urban water infrastructure and/or cemeteries	
Traditional	Pocket Park	Small landscaped informal spaces; limited passive amenities and no active amenities or facilities	400 m (¼ mile)
	Neighborhood Park	Landscaped spaces of varying size; passive and active amenities and facilities; located within residential areas	800 m (½ mile)
	Regional Park	Large landscaped and/or natural spaces; wide range of amenities and facilities; access primarily via car	1,600 m (1 mile)
Water	Natural Water	Contains natural water features (i.e., bay, river, lake)	400m
	Urban Water Infrastructure	Water features designed for stormwater management; may or may not offer social amenities	
	Total Water	Natural and urban-infrastructure water features	

C.2.2 Measuring Availability and Accessibility

Using ArcGIS (ESRI, 2010), three methods were used to measure green space, water availability, and access: 1) Container approach, 2) Minimum distance analysis, and 3) Service area analysis. A commonly accepted access distance is approximately 400 m (equivalent to a quarter mile or a 5 minute walk). This indicates the distance people are generally willing to walk to reach green space, and with the exception of neighborhood and regional parks, is used in this study to measure accessibility to green spaces.

C.2.2.1 Container Approach

This method allowed a baseline measure to be established regarding the availability of green space within each community. An aggregate access measure was calculated (acres per 1,000 residents) by quantifying the total acres of both public and traditional green space, which were then normalized by the population of each community. Although this method does not account for issues of quality or spatial distribution, it does allow two areas of different size or population to be evaluated based on a common measure.

Appendix C (Continued)

C.2.2.2 Minimum Distance Analysis

The minimum distance analysis allowed the nearest (Euclidean) distance from each census block group population centroid to the closest green space to be measured. An average minimum distance was then calculated for each community (including the average maximum distance), as well as the types of green space nearest the majority of residents. This not only allows an actual access distance to be measured, but also provides a tally of the green space types that are closest to the majority of residents within each community.

C.2.2.3 Service Area Analysis

Using this approach, issues of distribution, diversity, and accessibility were incorporated into the analysis. Previously defined access distances (Table C2) were used to delineate service areas around each green space. It was assumed that census block group population centroids located within these buffered service areas had access to the corresponding types of green space.

The following socio-demographic groups were evaluated: (1) Elderly (>65 years), (2) Youth (<18 years), (3) Single parents, (4) Whites, (5) Blacks, (6) Hispanics, (7) (Home) Owners, and (8) Renters. With the exception of Whites and Owners, these groups were identified from previous studies as either lacking green space access or having a greater need for easily accessible spaces. Income data is unavailable at the census block group level; therefore Renters and Owners were used as a surrogate.

For each green space category, the total and the sub-group populations with access were summed to estimate the portion of population with access. The overall access for each green space category was calculated by first dividing each sub-group population with access by the total population with access, then averaging those scores within each category. The averaged access scores were used to divide each sub-group into one of three levels of access: *Below* average access (<90% access), *Average* access (90-110%), and *Above* average access (>110%).

C.3 Results

Table C3 shows that although South Tampa has a larger total land area (and population) than East Tampa, it contains relatively fewer green spaces, which are also on average smaller in size. It was previously determined that disparities exist in East Tampa regarding green space availability and diversity relative to the larger city of Tampa (Wright Wendel et al., 2011b). Despite having greater green space diversity, South Tampa has lower aggregate access compared to East Tampa, with 3.7 acres of total public green space per 1,000 residents (compared to 12.9 per 1,000 residents for East Tampa). Furthermore, although both communities have a water feature in the majority of their public green spaces (72.7% and 80.4%), one third of South Tampa's green spaces contain a natural water feature while 0% of East Tampa's green spaces contain a natural water feature.

Appendix C (Continued)

Table C3. Comparison of green space characteristics for East Tampa (Wright Wendel et al., 2011b) and South Tampa.

	South Tampa	East Tampa
Total Green Space Area (acres)	7,166	4,811
Total Public (% total)	201 (2.8%)	398 (8.3%)
Total Traditional (% total)	112 (1.6%)	84 (1.7%)
Average Traditional size	5	6
Aggregate Green Space Access		
Public (acres/1,000 residents)	3.7	12.9
Traditional (acres/1,000 residents)	2.1	2.7
Residents per Traditional acre	485	371
% Green Space Type (% total Public)		
Total Traditional	*55.4%*	*21.0%*
Pocket Parks	5.0%	0.8%
Neighborhood Parks	29.1%	20.1%
Regional Parks	22.9%	0%
Total Water	*80.4%*	*72.7%*
Natural Water	33.3%	0%
Urban Water Infrastructure	43.0%	12.0%
Cemeteries	1.6%	67.1%

Table C4 provides the average minimum distance and the average maximum nearest distance for the different types of green space available to populations living in South Tampa and East Tampa. As visually represented in Figure C2, the majority of residents in both sites are closest to neighborhood parks and/or urban water infrastructure (81-86%). East Tampa residents have a shorter overall average minimum access distance relative to South Tampa residents (189 m compared to 337 m, respectively). In addition, within both communities, more than 60% of residents are closest to unconventional green spaces (i.e., cemeteries and urban water infrastructure), indicating their importance in the urban landscape.

Table C4. Average minimum and maximum distances for census block populations to access different types of green space in South Tampa and East Tampa. Also reported is the type of green space that is nearest to the populations residing in a particular area.

	South Tampa			East Tampa		
Green Space Type	**% green space nearest**	**Average Distance**	**Average Maximum Distance**	**% green space nearest**	**Average Distance**	**Average Maximum Distance**
Cemetery	4%	397	449	12%	135	509
Natural Water	6%	253	700	-	-	-
Pocket Park	10%	311	852	2%	193	554
Neighborhood Park	23%	380	1,028	38%	206	640
Urban Water Infrastructure	58%	344	1,074	48%	189	724

Appendix C (Continued)

Table C5 provides the percent of the population with access to the different types of green space within both South Tampa and East Tampa. With the exception of pocket and regional parks, East Tampa residents have greater access to the remaining types of green space than South Tampa residents. Considerable differences are noted for traditional green space (24.4% vs. 53.3%, respectively), with neighborhood parks in particular, as well as total public green spaces. Additionally, despite having natural water features surrounding two sides of South Tampa, fewer residents had access, as defined by living within a 400 m walking distance (Table C2), even compared to East Tampa which is in effect “landlocked”.

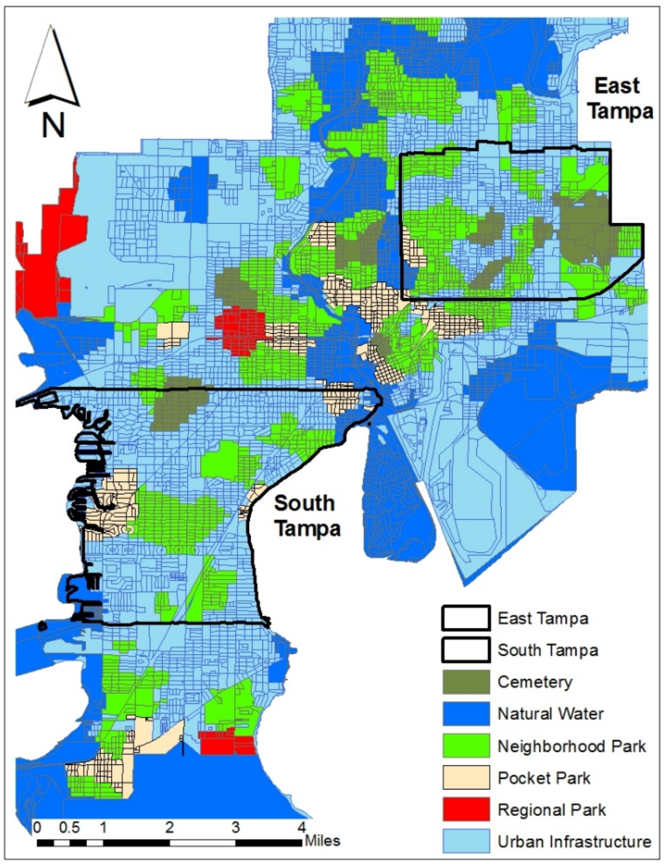

Figure C2. Types of green space closest to residents (census block groups) in South Tampa and East Tampa. Blue colors indicate the census block group has 400-m access to a natural or engineered water feature.

Appendix C (Continued)

Table C5. Percent access by the total population of South Tampa and East Tampa to each type of green space.

Green Space Access	South Tampa	East Tampa
Traditional	*24.4%*	*53.3%*
Pocket Park	6.5%	3.8%
Neighborhood Park	51.0%	95.6%
Regional Park	13.5%	1.9%
Water	*45.6%*	*69.1%*
Natural Water	2.1%	2.5%
Stormwater Ponds	42.6%	52.3%
Total Public	*53.9%*	*80.3%*
Unconventional	44.0%	56.7%

Table C6 provides the overall average access for each socio-demographic group to the three main categories of green space. Although South Tampa residents have a lower percentage of their total population with access to green space (Table C5), with the exception of Youth and Owners, the remaining groups had greater overall access than East Tampa residents. For example, in South Tampa, Blacks, Hispanics, Elderly, and Renters had above average access to green space with water features, whereas in East Tampa, they had only average access.

Table C6. Overall average access to the main green space categories (Traditional, Water, and Public) by each socio-demographic group in South Tampa and East Tampa.

Traditional Access	White	Black	Hispanic	Elderly	Youth	Single Parents	Owners	Renters
South Tampa	Average	Average	Average	Above	Below	Average	Below	Above
East Tampa	Average	Below	Average	Below	Average	Below	Below	Average
Water Access								
South Tampa	Average	Above	Above	Above	Below	Average	Below	Above
East Tampa	Below	Average	Average	Average	Average	Average	Average	Average
Public Access								
South Tampa	Average	Above	Above	Average	Below	Average	Average	Above
East Tampa	Below	Average	Below	Average	Average	Average	Average	Average

C.4 Discussion

The availability and accessibility of green spaces and water features was compared between two distinct communities that have similar population densities, development ages, and relative quantities of traditional (i.e., desirable) green spaces, but with substantially different socio-demographic characteristics and availability of natural water features and total public green spaces.

South Tampa is “water-locked” on two sides and has one-third of the total public green space with natural water features, whereas the “landlocked” East Tampa has none. Furthermore, unconventional green spaces (i.e., cemeteries and stormwater ponds) account for a larger portion of the total public green space in East Tampa (79%) than South Tampa (45%). As a result, more residents in East Tampa are in closest proximity to these unconventional, and less desirable, green spaces. However, despite the greater abundance of natural water features within South Tampa, very few residents (6%) have close access to these amenities, with the vast majority located in greater proximity to urban water infrastructures (58%). In fact, residents in both communities had just over two percent of their residents with access to these natural water features.

In many rapidly growing communities, access to public spaces and natural amenities has become less equitable (UN-HABITAT, 2008). This has been the case for the city of Tampa with high levels of private development along natural water features. Yet the unique geographical and cultural context present within South Tampa and East Tampa, including the prevalence of urban water infrastructures, represents an under-utilized potential for improving urban quality of life by enhancing these unconventional green spaces and water features. Currently, these single-purpose stormwater ponds provide very few social and environmental benefits. That is, although traditional water management in urban areas like Tampa have protected human health and property, engineered water infrastructures have concealed the urban hydrological cycle from the public.

Obtaining the support of stakeholders in decisions related to water management begins by building a better understanding of, and therefore contact with, the urban water cycle. However, many urban communities continue to be dominated by water infrastructure which has restricted access, thereby reducing the societal benefits of potential green spaces and surface water features. By improving the understanding of, and human contact with, urban water cycle management, a greater environmental awareness and stewardship can be fostered, as well as a better connection between stakeholders and critical issues of watershed protection and water reuse (Macpherson, 2010). This has long-term implications for improving urban quality of life while also decreasing economic and environmental costs of providing integrated water infrastructure to an urbanizing world (Maheepala et al., 2010). Although the geographical context of urban water management (and infrastructures) may differ between urban areas (i.e., use of stormwater ponds in Florida), there are unique solutions to enhancing the integration of water in the planning of cities of the future.

Appendix C (Continued)

Holistically planning for the integration of these “grey” infrastructures with natural systems (or “green” infrastructure) could provide new opportunities to not only reconnect residents to the urban water hydrological cycle, but also increase the availability of desirable green spaces and water features (Wright Wendel et al., 2011b). This will be increasingly important as urban centers continue to urbanize and become more densely developed, with additional pressures being placed on both natural and engineered infrastructures. This highlights the importance of designing, distributing, and operating these systems as multi-functional spaces that promote greater social, health, environmental, and economic outcomes.

Appendix D: Chapter 5 Supplemental Information

Table D1. Monthly temperature values at the Trompillo Airport in Santa Cruz, Bolivia (1970-2010).

Year	January	February	March	April	May	June	July	August	September	October	November	December
1970	28.2	27.5	26.5	26.9	22.9	21.0	20.9	23.5	28.2	28.5	28.7	27.0
1971	26.2	26.8	27.0	24.0	21.5	18.7	23.3	23.7	26.9	25.7	28.6	27.0
1972	27.8	27.8	26.3	24.8	25.0	23.7	21.2	21.2	26.0	26.3	27.8	27.6
1973	28.1	27.7	27.5	27.7	22.5	21.4	19.2	20.4	25.7	26.6	25.5	25.1
1974	25.3	24.9	25.4	22.8	23.3	20.5	21.0	22.6	25.1	24.0	27.0	26.1
1975	26.9	26.8	26.4	25.0	21.6	21.5	19.9	22.4	24.1	26.2	26.4	27.5
1976	26.3	26.6	25.0	25.2	21.9	20.0	22.2	23.4	22.2	26.7	26.5	26.2
1977	26.0	26.0	25.8	24.0	21.1	21.5	22.5	21.4	24.5	26.2	25.6	26.8
1978	26.8	26.9	27.2	24.9	22.2	20.9	23.7	21.6	25.1	27.3	26.9	26.5
1979	26.1	25.7	24.2	22.1	20.7	18.4	20.2	24.5	21.9	26.7	26.0	26.5
1980	25.4	25.4	25.3	23.0	22.3	19.5	19.4	21.1	22.6	25.3	24.7	26.1
1981	25.3	24.7	24.7	23.9	22.5	18.5	19.0	22.8	23.3	23.5	25.3	24.7
1982	25.6	23.9	24.1	23.4	20.8	19.2	20.5	21.5	22.8	24.1	24.4	25.4
1983	25.7	25.3	24.6	23.3	21.1	15.5	17.9	20.4	21.7	24.4	24.3	26.0
1984	24.5	24.7	25.4	21.5	22.6	16.5	20.8	19.8	24.4	27.0	24.6	24.8
1985	26.6	26.5	25.6	23.4	23.0	21.0	20.2	20.7	23.4	26.7	27.1	28.1
1986	25.8	25.2	24.7	24.5	22.3	21.0	20.2	22.2	22.2	25.0	26.3	26.9
1987	25.5	25.5	25.8	24.2	19.0	19.6	22.2	21.3	24.4	26.1	27.3	25.5
1988	26.0	26.8	26.3	23.9	19.3	20.2	18.4	24.4	24.8	26.8	27.9	26.4
1989	26.0	26.6	25.2	23.7	20.6	21.5	20.1	22.9	22.7	26.5	27.7	26.2
1990	25.7	26.3	26.6	25.1	21.2	19.0	18.3	22.8	23.0	26.6	26.9	26.3

Appendix D (Continued)

Table D1. (Continued)

1991	26.1	26.1	26.1	24.5	23.4	20.9	20.3	22.4	24.3	25.2	25.7	25.8
1992	27.2	25.5	25.5	23.5	21.6	21.0	16.6	20.9	21.9	25.1	25.8	26.8
1993	26.0	26.5	27.0	24.4	21.8	21.6	19.2	21.3	22.7	26.1	26.6	26.4
1994	27.3	25.8	25.6	24.0	23.8	21.8	21.0	24.1	26.4	26.0	27.9	27.1
1995	26.2	26.0	26.2	23.7	22.2	22.2	21.3	22.8	25.4	26.9	27.7	27.5
1996	26.2	25.7	26.5	24.5	22.6	18.0	20.9	24.2	23.8	25.0	26.2	25.2
1997	22.1	21.3	21.0	20.3	18.4	17.7	16.7	14.3	18.5	19.9	20.9	22.5
1998	28.5	27.2	26.2	25.4	22.6	21.6	23.6	23.0	23.1	26.2	26.5	27.1
1999	27.0	27.7	26.1	23.8	21.8	20.0	19.4	23.4	27.8	27.7	27.7	26.6
2000	27.9	26.8	25.2	25.6	21.4	21.2	18.4	23.4	24.1	27.0	26.0	25.8
2001	26.3	27.1	25.7	24.8	20.4	20.0	22.0	25.3	25.4	26.9	26.1	27.8
2002	28.2	25.6	26.1	24.4	23.8	19.3	20.0	24.4	25.8	28.0	27.1	26.1
2003	26.7	25.1	25.7	24.5	23.7	23.1	21.0	22.3	25.2	26.9	27.3	25.6
2004	28.6	27.1	26.8	24.6	19.2	20.9	20.5	23.4	26.4	26.7	26.4	27.2
2005	27.7	27.7	26.7	24.0	22.3	21.7	20.7	23.8	21.8	24.9	26.5	27.0
2006	26.7	27.1	26.1	25.2	20.9	22.2	23.1	24.2	24.8	26.9	27.3	26.6
2007	25.8	26.1	25.8	25.6	20.2	22.1	20.1	21.2	27.1	27.2	25.4	26.3
2008	26.0	26.1	25.8	23.9	21.7	18.5	23.8	23.8	24.5	26.1	28.0	27.7
2009	26.7	26.4	26.5	26.3	23.0	20.3	20.4	23.5	24.4	26.4	27.5	26.4
2010	26.3	26.4	27.9	24.8	21.3	22.0	20.3	22.4	24.0	26.0	26.4	26.3

Appendix D (Continued)

Table D2. Temperature projections based on IPCC emission scenario A1B (2011-2050).

Year	January	February	March	April	May	June	July	August	September	October	November	December
2011	26.3	26.4	27.9	24.9	21.4	22.0	20.3	22.5	24.1	26.1	26.5	26.4
2012	26.4	26.5	28.0	24.9	21.4	22.0	20.4	22.5	24.1	26.2	26.5	26.4
2013	26.4	26.6	28.0	24.9	21.5	22.1	20.4	22.6	24.2	26.2	26.6	26.4
2014	26.4	26.6	28.0	24.9	21.5	22.1	20.5	22.6	24.2	26.3	26.7	26.5
2015	26.5	26.7	28.1	24.9	21.6	22.1	20.5	22.7	24.3	26.4	26.7	26.5
2016	26.5	26.7	28.1	25.0	21.6	22.1	20.5	22.7	24.4	26.5	26.8	26.6
2017	26.5	26.8	28.1	25.0	21.7	22.1	20.6	22.8	24.4	26.5	26.9	26.6
2018	26.5	26.9	28.2	25.0	21.8	22.2	20.6	22.8	24.5	26.6	26.9	26.6
2019	26.6	26.9	28.2	25.0	21.8	22.2	20.7	22.9	24.5	26.7	27.0	26.7
2020	26.6	27.0	28.2	25.0	21.9	22.2	20.7	22.9	24.6	26.8	27.1	26.7
2021	26.6	27.0	28.3	25.1	21.9	22.2	20.8	23.0	24.6	26.9	27.1	26.8
2022	26.6	27.1	28.3	25.1	22.0	22.2	20.8	23.1	24.7	26.9	27.2	26.8
2023	26.7	27.2	28.4	25.1	22.0	22.3	20.9	23.1	24.7	27.0	27.3	26.9
2024	26.7	27.2	28.4	25.1	22.1	22.3	20.9	23.2	24.8	27.1	27.3	26.9
2025	26.7	27.3	28.4	25.1	22.1	22.3	20.9	23.2	24.8	27.2	27.4	26.9
2026	26.8	27.4	28.5	25.2	22.2	22.3	21.0	23.3	24.9	27.2	27.5	27.0
2027	26.8	27.4	28.5	25.2	22.3	22.4	21.0	23.3	25.0	27.3	27.5	27.0
2028	26.8	27.5	28.5	25.2	22.3	22.4	21.1	23.4	25.0	27.4	27.6	27.1
2029	26.8	27.5	28.6	25.2	22.4	22.4	21.1	23.4	25.1	27.5	27.7	27.1
2030	26.9	27.6	28.6	25.2	22.4	22.4	21.2	23.5	25.1	27.6	27.7	27.1

Appendix D (Continued)

Table D2. (Continued)

Year	January	February	March	April	May	June	July	August	September	October	November	December
2031	26.9	27.7	28.6	25.3	22.5	22.4	21.2	23.5	25.2	27.6	27.8	27.2
2032	26.9	27.7	28.7	25.3	22.5	22.5	21.3	23.6	25.2	27.7	27.9	27.2
2033	26.9	27.8	28.7	25.3	22.6	22.5	21.3	23.6	25.3	27.8	28.0	27.3
2034	27.0	27.9	28.7	25.3	22.7	22.5	21.4	23.7	25.3	27.9	28.0	27.3
2035	27.0	27.9	28.8	25.3	22.7	22.5	21.4	23.8	25.4	28.0	28.1	27.4
2036	27.0	28.0	28.8	25.3	22.8	22.5	21.5	23.8	25.5	28.1	28.2	27.4
2037	27.1	28.0	28.8	25.4	22.8	22.6	21.5	23.9	25.5	28.1	28.2	27.4
2038	27.1	28.1	28.9	25.4	22.9	22.6	21.5	23.9	25.6	28.2	28.3	27.5
2039	27.2	28.2	29.0	25.4	23.1	22.6	21.7	24.2	25.7	28.6	28.5	27.6
2040	27.2	28.2	29.1	25.5	23.2	22.7	21.8	24.2	25.8	28.7	28.6	27.7
2041	27.3	28.4	29.1	25.6	23.3	22.8	21.9	24.3	25.9	28.8	28.7	27.8
2042	27.4	28.5	29.2	25.7	23.4	22.8	21.9	24.4	26.0	28.9	28.9	27.9
2043	27.4	28.6	29.3	25.8	23.5	22.9	22.0	24.5	26.1	29.0	29.0	28.0
2044	27.5	28.7	29.3	25.9	23.6	23.0	22.1	24.6	26.2	29.2	29.2	28.1
2045	27.6	28.8	29.4	26.0	23.7	23.1	22.2	24.6	26.3	29.3	29.3	28.2
2046	27.7	28.9	29.5	26.1	23.8	23.2	22.2	24.7	26.4	29.4	29.5	28.3
2047	27.7	29.0	29.6	26.2	23.9	23.3	22.3	24.8	26.5	29.5	29.6	28.3
2048	27.8	29.1	29.6	26.3	24.0	23.4	22.4	24.9	26.6	29.7	29.8	28.4
2049	27.9	29.2	29.7	26.4	24.1	23.5	22.5	25.0	26.7	29.8	29.9	28.5
2050	28.0	29.3	29.8	26.5	24.2	23.6	22.5	25.1	26.8	29.9	30.1	28.6

Appendix D (Continued)

Table D3. Temperature projections based on IPCC emission scenario A2 (2011-2050).

Year	January	February	March	April	May	June	July	August	September	October	November	December
2011	26.3	26.4	27.9	24.9	21.4	22.0	20.3	22.5	24.1	26.1	26.5	26.3
2012	26.4	26.5	28.0	24.9	21.4	22.1	20.4	22.5	24.1	26.1	26.5	26.4
2013	26.4	26.5	28.0	25.0	21.5	22.1	20.4	22.6	24.2	26.2	26.6	26.4
2014	26.4	26.6	28.0	25.0	21.5	22.2	20.5	22.6	24.3	26.3	26.7	26.4
2015	26.5	26.6	28.1	25.1	21.6	22.2	20.5	22.6	24.3	26.4	26.7	26.5
2016	26.5	26.7	28.1	25.1	21.6	22.2	20.6	22.7	24.4	26.4	26.8	26.5
2017	26.5	26.7	28.1	25.2	21.7	22.3	20.6	22.7	24.4	26.5	26.9	26.5
2018	26.5	26.8	28.2	25.2	21.7	22.3	20.6	22.8	24.5	26.6	27.0	26.6
2019	26.6	26.8	28.2	25.2	21.8	22.4	20.7	22.8	24.5	26.7	27.0	26.6
2020	26.6	26.9	28.2	25.3	21.8	22.4	20.7	22.9	24.6	26.7	27.1	26.6
2021	26.6	26.9	28.3	25.3	21.9	22.5	20.8	22.9	24.7	26.8	27.2	26.6
2022	26.7	27.0	28.3	25.4	21.9	22.5	20.8	23.0	24.7	26.9	27.2	26.7
2023	26.7	27.0	28.3	25.4	22.0	22.5	20.9	23.0	24.8	27.0	27.3	26.7
2024	26.7	27.0	28.4	25.5	22.0	22.6	20.9	23.1	24.8	27.0	27.4	26.7
2025	26.7	27.1	28.4	25.5	22.1	22.6	21.0	23.1	24.9	27.1	27.4	26.8
2026	26.8	27.1	28.4	25.6	22.1	22.7	21.0	23.1	24.9	27.2	27.5	26.8
2027	26.8	27.2	28.5	25.6	22.2	22.7	21.1	23.2	25.0	27.3	27.6	26.8
2028	26.8	27.2	28.5	25.7	22.2	22.8	21.1	23.2	25.1	27.4	27.7	26.9
2029	26.8	27.3	28.5	25.7	22.3	22.8	21.2	23.3	25.1	27.4	27.7	26.9
2030	26.9	27.3	28.6	25.8	22.3	22.9	21.2	23.3	25.2	27.5	27.8	26.9

Appendix D (Continued)

Table D3. (Continued)

Year	January	February	March	April	May	June	July	August	September	October	November	December
2031	26.9	27.4	28.6	25.8	22.4	22.9	21.3	23.4	25.2	27.6	27.9	26.9
2032	26.9	27.4	28.6	25.9	22.4	22.9	21.3	23.4	25.3	27.7	27.9	27.0
2033	27.0	27.5	28.7	25.9	22.5	23.0	21.4	23.5	25.4	27.7	28.0	27.0
2034	27.0	27.5	28.7	25.9	22.5	23.0	21.4	23.5	25.4	27.8	28.1	27.0
2035	27.0	27.6	28.7	26.0	22.6	23.1	21.5	23.6	25.5	27.9	28.2	27.1
2036	27.0	27.6	28.8	26.0	22.6	23.1	21.5	23.6	25.5	28.0	28.2	27.1
2037	27.1	27.7	28.8	26.1	22.7	23.2	21.6	23.7	25.6	28.1	28.3	27.1
2038	27.1	27.7	28.8	26.1	22.7	23.2	21.6	23.7	25.7	28.1	28.4	27.2
2039	27.2	27.8	29.0	26.3	22.9	23.3	21.8	23.9	25.8	28.5	28.6	27.3
2040	27.2	27.8	29.0	26.3	23.0	23.4	21.9	23.9	25.9	28.6	28.7	27.3
2041	27.3	27.9	29.1	26.4	23.1	23.4	21.9	24.0	26.0	28.7	28.8	27.4
2042	27.4	28.0	29.1	26.5	23.2	23.5	22.0	24.1	26.1	28.8	28.9	27.5
2043	27.4	28.1	29.2	26.6	23.2	23.6	22.1	24.2	26.2	28.9	29.0	27.5
2044	27.5	28.2	29.3	26.7	23.3	23.7	22.2	24.3	26.3	29.0	29.1	27.6
2045	27.6	28.3	29.4	26.8	23.4	23.7	22.3	24.3	26.4	29.1	29.3	27.7
2046	27.7	28.4	29.5	26.9	23.5	23.8	22.3	24.4	26.5	29.3	29.4	27.8
2047	27.7	28.5	29.6	27.0	23.6	23.9	22.4	24.5	26.5	29.4	29.5	27.9
2048	27.8	28.6	29.6	27.1	23.7	23.9	22.5	24.6	26.6	29.5	29.6	28.0
2049	27.9	28.7	29.7	27.2	23.8	24.0	22.6	24.6	26.7	29.6	29.7	28.0
2050	28.0	28.8	29.8	27.3	23.8	24.1	22.7	24.7	26.8	29.7	29.8	28.1

Appendix D (Continued)

Table D4. Temperature projections based on IPCC emission scenario B1 (2011-2050).

Year	January	February	March	April	May	June	July	August	September	October	November	December
2011	26.4	26.4	27.9	24.9	21.3	22.0	20.3	22.5	24.1	26.1	26.5	26.4
2012	26.4	26.5	27.9	24.9	21.4	22.1	20.4	22.5	24.1	26.1	26.5	26.4
2013	26.4	26.5	28.0	24.9	21.4	22.1	20.4	22.5	24.2	26.2	26.6	26.4
2014	26.5	26.6	28.0	25.0	21.4	22.1	20.5	22.6	24.2	26.2	26.6	26.5
2015	26.5	26.6	28.0	25.0	21.5	22.1	20.6	22.6	24.3	26.3	26.7	26.5
2016	26.6	26.6	28.0	25.1	21.5	22.2	20.6	22.7	24.3	26.4	26.7	26.5
2017	26.6	26.7	28.0	25.1	21.5	22.2	20.7	22.7	24.4	26.4	26.8	26.6
2018	26.6	26.7	28.1	25.1	21.5	22.2	20.7	22.7	24.4	26.5	26.9	26.6
2019	26.7	26.8	28.1	25.2	21.6	22.3	20.8	22.8	24.5	26.5	26.9	26.7
2020	26.7	26.8	28.1	25.2	21.6	22.3	20.8	22.8	24.5	26.6	27.0	26.7
2021	26.8	26.8	28.1	25.2	21.6	22.3	20.9	22.9	24.6	26.6	27.0	26.7
2022	26.8	26.9	28.1	25.3	21.7	22.3	21.0	22.9	24.6	26.7	27.1	26.8
2023	26.8	26.9	28.2	25.3	21.7	22.4	21.0	22.9	24.7	26.8	27.2	26.8
2024	26.9	27.0	28.2	25.3	21.7	22.4	21.1	23.0	24.7	26.8	27.2	26.9
2025	26.9	27.0	28.2	25.4	21.7	22.4	21.1	23.0	24.8	26.9	27.3	26.9
2026	27.0	27.0	28.2	25.4	21.8	22.5	21.2	23.0	24.9	26.9	27.3	26.9
2027	27.0	27.1	28.2	25.5	21.8	22.5	21.2	23.1	24.9	27.0	27.4	27.0
2028	27.0	27.1	28.3	25.5	21.8	22.5	21.3	23.1	25.0	27.1	27.5	27.0
2029	27.1	27.2	28.3	25.5	21.8	22.5	21.4	23.2	25.0	27.1	27.5	27.1
2030	27.1	27.2	28.3	25.6	21.9	22.6	21.4	23.2	25.1	27.2	27.6	27.1

Appendix D (Continued)

Table D4. (Continued)

Year	January	February	March	April	May	June	July	August	September	October	November	December
2031	27.2	27.3	28.3	25.6	21.9	22.6	21.5	23.2	25.1	27.2	27.6	27.1
2032	27.2	27.3	28.3	25.6	21.9	22.6	21.5	23.3	25.2	27.3	27.7	27.2
2033	27.3	27.3	28.4	25.7	22.0	22.7	21.6	23.3	25.2	27.4	27.8	27.2
2034	27.3	27.4	28.4	25.7	22.0	22.7	21.6	23.4	25.3	27.4	27.8	27.3
2035	27.3	27.4	28.4	25.8	22.0	22.7	21.7	23.4	25.3	27.5	27.9	27.3
2036	27.4	27.5	28.4	25.8	22.0	22.7	21.8	23.5	25.4	27.5	27.9	27.3
2037	27.4	27.5	28.4	25.8	22.1	22.8	21.8	23.5	25.4	27.6	28.0	27.4
2038	27.5	27.6	28.5	25.9	22.1	22.8	21.9	23.5	25.5	27.7	28.1	27.4
2039	27.6	27.6	28.5	26.0	22.2	22.9	22.1	23.7	25.6	27.9	28.3	27.6
2040	27.7	27.6	28.5	26.0	22.2	22.9	22.2	23.7	25.7	28.0	28.3	27.6
2041	27.7	27.7	28.6	26.1	22.3	23.0	22.3	23.8	25.8	28.0	28.4	27.7
2042	27.8	27.8	28.7	26.1	22.3	23.0	22.3	23.8	25.8	28.1	28.4	27.7
2043	27.8	27.8	28.7	26.2	22.4	23.1	22.4	23.9	25.9	28.2	28.5	27.8
2044	27.9	27.9	28.8	26.2	22.5	23.1	22.4	24.0	25.9	28.2	28.5	27.8
2045	27.9	27.9	28.8	26.3	22.5	23.2	22.5	24.0	26.0	28.3	28.6	27.9
2046	28.0	28.0	28.9	26.4	22.6	23.3	22.5	24.1	26.0	28.3	28.7	27.9
2047	28.1	28.1	28.9	26.4	22.6	23.3	22.6	24.1	26.1	28.4	28.7	28.0
2048	28.1	28.1	29.0	26.5	22.7	23.4	22.7	24.2	26.2	28.4	28.8	28.1
2049	28.2	28.2	29.1	26.5	22.7	23.4	22.7	24.2	26.2	28.5	28.8	28.1
2050	28.2	28.3	29.1	26.6	22.8	23.5	22.8	24.3	26.3	28.6	28.9	28.2

Appendix D (Continued)

Table D5. Precipitation projections based on IPCC emission scenario A1B (2011-2050).

Year	January	February	March	April	May	June	July	August	September	October	November	December
2011	198.1	157.8	143.8	101.2	76.4	57.6	48.5	41.8	61.6	113.6	147.4	183.5
2012	198.6	157.0	144.7	101.3	76.4	57.6	48.5	41.7	61.6	112.5	144.8	184.0
2013	199.1	156.2	145.7	101.5	76.3	57.7	48.5	41.7	61.5	111.4	142.2	184.4
2014	199.6	155.5	146.7	101.6	76.3	57.7	48.5	41.7	61.5	110.4	139.6	184.9
2015	200.1	154.7	147.7	101.7	76.3	57.7	48.5	41.7	61.4	109.3	137.1	185.3
2016	200.6	153.9	148.7	101.9	76.2	57.8	48.5	41.6	61.3	108.2	134.7	185.8
2017	201.2	153.1	149.7	102.0	76.2	57.8	48.5	41.6	61.3	107.2	132.3	186.3
2018	201.7	152.4	150.7	102.2	76.1	57.8	48.5	41.6	61.2	106.1	129.9	186.7
2019	202.2	151.6	151.7	102.3	76.1	57.9	48.5	41.6	61.2	105.1	127.6	187.2
2020	202.7	150.9	152.7	102.5	76.1	57.9	48.5	41.5	61.1	104.1	125.3	187.6
2021	203.2	150.1	153.7	102.6	76.0	57.9	48.5	41.5	61.0	103.0	123.0	188.1
2022	203.8	149.4	154.8	102.7	76.0	58.0	48.5	41.5	61.0	102.0	120.8	188.6
2023	204.3	148.6	155.8	102.9	76.0	58.0	48.5	41.5	60.9	101.0	118.7	189.1
2024	204.8	147.9	156.8	103.0	75.9	58.0	48.5	41.4	60.8	100.1	116.6	189.5
2025	205.4	147.1	157.9	103.2	75.9	58.1	48.5	41.4	60.8	99.1	114.5	190.0
2026	205.9	146.4	159.0	103.3	75.8	58.1	48.5	41.4	60.7	98.1	112.4	190.5
2027	206.4	145.7	160.0	103.5	75.8	58.1	48.6	41.4	60.7	97.2	110.4	190.9
2028	206.9	144.9	161.1	103.6	75.8	58.2	48.6	41.3	60.6	96.2	108.4	191.4
2029	207.5	144.2	162.2	103.8	75.7	58.2	48.6	41.3	60.5	95.3	106.5	191.9
2030	208.0	143.5	163.3	103.9	75.7	58.2	48.6	41.3	60.5	94.3	104.6	192.4

Appendix D (Continued)

Table D5. (Continued)

Year	January	February	March	April	May	June	July	August	September	October	November	December
2031	208.5	142.8	164.4	104.0	75.7	58.3	48.6	41.3	60.4	93.4	102.7	192.8
2032	209.1	142.1	165.5	104.2	75.6	58.3	48.6	41.2	60.4	92.5	100.9	193.3
2033	209.6	141.4	166.6	104.3	75.6	58.3	48.6	41.2	60.3	91.6	99.1	193.8
2034	210.2	140.7	167.7	104.5	75.5	58.4	48.6	41.2	60.2	90.7	97.3	194.3
2035	210.7	140.0	168.8	104.6	75.5	58.4	48.6	41.2	60.2	89.8	95.6	194.8
2036	211.2	139.3	170.0	104.8	75.5	58.5	48.6	41.1	60.1	89.0	93.9	195.2
2037	211.8	138.6	171.1	104.9	75.4	58.5	48.6	41.1	60.1	88.1	92.2	195.7
2038	212.3	137.9	172.3	105.1	75.4	58.5	48.6	41.1	60.0	87.2	90.5	196.2
2039	215.3	138.3	181.6	105.6	75.3	58.6	48.6	41.0	59.8	87.3	95.9	198.8
2040	215.8	137.6	182.8	105.8	75.2	58.7	48.6	41.0	59.8	86.4	94.2	199.3
2041	215.7	137.2	183.1	105.9	75.0	58.6	48.6	41.0	59.7	85.1	67.5	198.2
2042	215.6	136.7	183.4	106.1	74.9	58.6	48.6	40.9	59.6	83.8	48.4	197.2
2043	215.5	136.3	183.6	106.2	74.7	58.6	48.6	40.9	59.5	82.5	34.7	196.1
2044	215.4	135.9	183.9	106.4	74.5	58.5	48.6	40.9	59.4	81.2	24.9	195.1
2045	215.3	135.4	184.2	106.5	74.3	58.5	48.6	40.9	59.3	80.0	17.9	194.0
2046	215.2	135.0	184.4	106.7	74.1	58.5	48.6	40.8	59.2	78.8	12.8	193.0
2047	215.1	134.6	184.7	106.8	74.0	58.4	48.6	40.8	59.1	77.6	9.2	191.9
2048	215.0	134.1	185.0	107.0	73.8	58.4	48.6	40.8	59.0	76.4	6.6	190.9
2049	214.9	133.7	185.2	107.1	73.6	58.3	48.5	40.8	58.9	75.2	4.7	189.9
2050	214.8	133.3	185.5	107.3	73.4	58.3	48.5	40.7	58.8	74.0	3.4	188.8

Appendix D (Continued)

Table D6. Precipitation projections based on IPCC emission scenario A2 (2011-2050).

Year	January	February	March	April	May	June	July	August	September	October	November	December
2011	198.1	157.8	143.8	101.2	76.4	57.6	48.5	41.8	61.6	113.6	147.4	183.5
2012	199.8	158.2	144.4	101.4	76.3	57.6	48.5	41.8	61.5	112.9	144.3	184.1
2013	201.6	158.5	145.0	101.7	76.3	57.6	48.5	41.8	61.4	112.2	141.2	184.7
2014	203.4	158.9	145.7	101.9	76.2	57.7	48.5	41.8	61.3	111.5	138.3	185.3
2015	205.2	159.3	146.3	102.2	76.2	57.7	48.5	41.9	61.2	110.7	135.3	185.9
2016	207.0	159.6	146.9	102.5	76.1	57.7	48.5	41.9	61.1	110.0	132.5	186.5
2017	208.8	160.0	147.6	102.7	76.0	57.7	48.5	41.9	61.0	109.3	129.7	187.1
2018	210.6	160.3	148.2	103.0	76.0	57.7	48.5	41.9	60.8	108.6	127.0	187.7
2019	212.5	160.7	148.9	103.2	75.9	57.8	48.5	42.0	60.7	107.9	124.3	188.3
2020	214.4	161.1	149.6	103.5	75.9	57.8	48.5	42.0	60.6	107.2	121.7	188.9
2021	216.3	161.4	150.2	103.7	75.8	57.8	48.5	42.0	60.5	106.5	119.1	189.5
2022	218.2	161.8	150.9	104.0	75.7	57.8	48.5	42.0	60.4	105.8	116.6	190.1
2023	220.1	162.2	151.5	104.3	75.7	57.9	48.5	42.1	60.3	105.2	114.1	190.7
2024	222.1	162.6	152.2	104.5	75.6	57.9	48.5	42.1	60.2	104.5	111.7	191.4
2025	224.0	162.9	152.9	104.8	75.6	57.9	48.5	42.1	60.1	103.8	109.4	192.0
2026	226.0	163.3	153.5	105.1	75.5	57.9	48.5	42.1	59.9	103.1	107.1	192.6
2027	228.0	163.7	154.2	105.3	75.4	57.9	48.5	42.2	59.8	102.5	104.8	193.2
2028	230.0	164.0	154.9	105.6	75.4	58.0	48.5	42.2	59.7	101.8	102.6	193.9
2029	232.0	164.4	155.6	105.9	75.3	58.0	48.5	42.2	59.6	101.2	100.4	194.5
2030	234.1	164.8	156.3	106.1	75.3	58.0	48.5	42.2	59.5	100.5	98.3	195.1

Appendix D (Continued)

Table D6. (Continued)

Year	January	February	March	April	May	June	July	August	September	October	November	December
2031	236.1	165.2	157.0	106.4	75.2	58.0	48.5	42.3	59.4	99.9	96.2	195.7
2032	238.2	165.6	157.6	106.7	75.1	58.0	48.5	42.3	59.3	99.2	94.2	196.4
2033	240.3	165.9	158.3	106.9	75.1	58.1	48.5	42.3	59.2	98.6	92.2	197.0
2034	242.4	166.3	159.0	107.2	75.0	58.1	48.5	42.3	59.1	97.9	90.3	197.6
2035	244.6	166.7	159.7	107.5	75.0	58.1	48.5	42.4	58.9	97.3	88.4	198.3
2036	246.7	167.1	160.4	107.7	74.9	58.1	48.5	42.4	58.8	96.7	86.5	198.9
2037	248.9	167.5	161.1	108.0	74.8	58.2	48.5	42.4	58.7	96.0	84.7	199.6
2038	251.1	167.8	161.9	108.3	74.8	58.2	48.5	42.4	58.6	95.4	82.9	200.2
2039	272.7	168.7	166.5	109.4	74.6	58.2	48.5	42.6	58.4	94.7	90.3	203.9
2040	275.1	169.1	167.2	109.7	74.5	58.3	48.5	42.6	58.3	94.1	88.4	204.6
2041	275.3	168.4	167.9	109.8	74.4	58.3	48.5	42.6	58.2	92.9	78.3	204.9
2042	275.5	167.8	168.5	110.0	74.4	58.3	48.5	42.5	58.1	91.8	69.4	205.2
2043	275.8	167.2	169.2	110.1	74.3	58.4	48.5	42.5	58.0	90.7	61.6	205.6
2044	276.0	166.5	169.9	110.2	74.2	58.4	48.5	42.5	57.9	89.6	54.6	205.9
2045	276.2	165.9	170.5	110.3	74.1	58.4	48.5	42.5	57.8	88.5	48.4	206.2
2046	276.4	165.3	171.2	110.5	74.1	58.4	48.5	42.5	57.7	87.4	42.9	206.6
2047	276.7	164.6	171.9	110.6	74.0	58.5	48.5	42.4	57.6	86.3	38.0	206.9
2048	276.9	164.0	172.6	110.7	73.9	58.5	48.5	42.4	57.5	85.2	33.7	207.2
2049	277.1	163.4	173.3	110.8	73.8	58.5	48.5	42.4	57.4	84.2	29.9	207.5
2050	277.3	162.8	173.9	111.0	73.8	58.6	48.5	42.4	57.3	83.1	26.5	207.9

Appendix D (Continued)

Table D7. Precipitation projections based on IPCC emission scenario B1 (2011-2050).

Year	January	February	March	April	May	June	July	August	September	October	November	December
2011	198.1	157.8	143.8	101.2	76.4	57.6	48.5	41.8	61.6	113.6	147.4	183.5
2012	198.8	158.5	144.4	101.8	77.0	58.2	49.0	42.2	62.2	114.3	148.1	184.2
2013	199.5	159.3	145.1	102.5	77.6	58.7	49.5	42.7	62.8	114.9	148.8	184.9
2014	200.2	160.0	145.8	103.1	78.2	59.3	50.1	43.2	63.4	115.6	149.5	185.6
2015	200.9	160.8	146.4	103.8	78.8	59.9	50.6	43.8	64.0	116.2	150.2	186.3
2016	201.6	161.5	147.1	104.5	79.4	60.5	51.1	44.3	64.6	116.9	150.9	187.0
2017	202.3	162.3	147.8	105.1	80.0	61.1	51.7	44.8	65.2	117.5	151.6	187.7
2018	203.0	163.0	148.5	105.8	80.6	61.7	52.2	45.3	65.8	118.2	152.3	188.4
2019	203.7	163.8	149.2	106.5	81.2	62.3	52.8	45.9	66.4	118.9	153.0	189.1
2020	204.4	164.6	149.8	107.2	81.9	62.9	53.4	46.4	67.0	119.5	153.7	189.8
2021	205.1	165.3	150.5	107.8	82.5	63.5	53.9	46.9	67.7	120.2	154.4	190.5
2022	205.8	166.1	151.2	108.5	83.1	64.1	54.5	47.5	68.3	120.9	155.1	191.2
2023	206.5	166.9	151.9	109.2	83.8	64.7	55.1	48.1	68.9	121.6	155.9	191.9
2024	207.3	167.7	152.6	109.9	84.4	65.4	55.7	48.6	69.6	122.3	156.6	192.6
2025	208.0	168.5	153.3	110.6	85.1	66.0	56.3	49.2	70.2	122.9	157.3	193.3
2026	208.7	169.2	154.0	111.3	85.7	66.7	56.9	49.8	70.9	123.6	158.1	194.1
2027	209.4	170.0	154.8	112.0	86.4	67.3	57.5	50.4	71.5	124.3	158.8	194.8
2028	210.2	170.8	155.5	112.8	87.1	68.0	58.1	51.0	72.2	125.0	159.5	195.5
2029	210.9	171.6	156.2	113.5	87.7	68.7	58.7	51.6	72.9	125.7	160.3	196.2
2030	211.6	172.4	156.9	114.2	88.4	69.3	59.3	52.2	73.6	126.4	161.0	197.0

Appendix D (Continued)

Table D7. (Continued)

Year	January	February	March	April	May	June	July	August	September	October	November	December
2031	212.4	173.2	157.6	114.9	89.1	70.0	60.0	52.8	74.3	127.2	161.8	197.7
2032	213.1	174.0	158.4	115.7	89.8	70.7	60.6	53.4	74.9	127.9	162.6	198.4
2033	213.9	174.9	159.1	116.4	90.5	71.4	61.3	54.0	75.6	128.6	163.3	199.2
2034	214.6	175.7	159.8	117.2	91.2	72.1	61.9	54.7	76.4	129.3	164.1	199.9
2035	215.4	176.5	160.6	117.9	91.9	72.8	62.6	55.3	77.1	130.0	164.8	200.7
2036	216.1	177.3	161.3	118.7	92.6	73.5	63.2	56.0	77.8	130.8	165.6	201.4
2037	216.9	178.2	162.1	119.4	93.3	74.2	63.9	56.6	78.5	131.5	166.4	202.2
2038	217.6	179.0	162.8	120.2	94.0	75.0	64.6	57.3	79.2	132.2	167.2	202.9
2039	222.1	181.8	167.8	125.2	100.4	81.6	72.5	65.8	85.7	137.7	171.4	207.5
2040	222.9	182.7	168.6	126.0	101.2	82.4	73.3	66.6	86.5	138.4	172.2	208.3
2041	222.5	182.3	168.2	125.6	100.8	82.0	72.9	66.1	86.0	138.1	171.8	207.9
2042	222.1	181.8	167.8	125.2	100.4	81.6	72.4	65.7	85.6	137.7	171.4	207.5
2043	221.7	181.4	167.4	124.8	100.0	81.1	72.0	65.3	85.2	137.3	171.0	207.2
2044	221.4	181.0	167.0	124.4	99.6	80.7	71.6	64.8	84.8	136.9	170.6	206.8
2045	221.0	180.6	166.6	124.0	99.2	80.3	71.2	64.4	84.4	136.5	170.2	206.4
2046	220.6	180.2	166.3	123.6	98.8	79.9	70.8	64.0	83.9	136.1	169.9	206.0
2047	220.2	179.8	165.9	123.2	98.4	79.5	70.4	63.6	83.5	135.7	169.5	205.7
2048	219.9	179.3	165.5	122.8	98.0	79.0	70.0	63.2	83.1	135.4	169.1	205.3
2049	219.5	178.9	165.1	122.4	97.6	78.6	69.6	62.8	82.7	135.0	168.7	204.9
2050	219.1	178.5	164.7	122.0	97.2	78.2	69.2	62.4	82.3	134.6	168.3	204.5

Appendix D (Continued)

Table D8. Water balance output values (1970-2009).

	1970												1971							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A
P(t)	94.5	23.1	52.0	39.8	60.8	22.6	47.5	9.4	6.0	61.2	159.5	104.0	144.2	89.1	46.5	61.5	33.4	49.3	13.6	38.4
PE(t)	180.6	165.5	145.4	152.6	87.0	63.9	63.3	95.4	181.0	189.0	191.7	155.7	142.2	152.5	156.3	106.6	74.3	47.6	97.1	101.6
W(t)	1594.5	1450.1	1365.5	1292.0	1241.2	1200.9	1203.3	1167.8	1109.5	1058.8	1107.1	1093.2	1141.7	1139.0	1087.6	1053.6	1022.8	1028.1	1012.8	994.8
Y(t)	1585.4	1446.5	1363.0	1290.2	1239.6	1199.6	1201.9	1166.6	1108.6	1058.0	1106.1	1092.3	1140.6	1137.9	1086.8	1052.8	1022.1	1027.4	1012.1	994.2
Sw(t)	1427.0	1313.5	1252.2	1180.4	1178.3	1155.8	1158.4	1103.5	997.6	947.6	989.2	997.5	1049.9	1041.1	992.1	989.4	978.8	999.2	956.4	937.0
Ro(t)	6.6	2.6	1.8	1.3	1.1	0.9	1.0	0.8	0.7	0.6	0.7	0.6	0.8	0.8	0.6	0.6	0.5	0.5	0.5	0.5
Rg(t)	2.5	1.0	0.7	0.5	0.4	0.4	0.4	0.3	0.3	0.2	0.3	0.2	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2
Sg(t)	4927.2	4921.8	4916.1	4910.2	4904.2	4898.1	4892.1	4886.1	4880.0	4873.8	4867.7	4861.6	4855.6	4849.6	4843.5	4837.4	4831.3	4825.2	4819.1	4813.0
Qg(t)	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3
Q(t)	13.0	9.1	8.2	7.7	7.5	7.3	7.3	7.2	7.1	6.9	7.0	7.0	7.1	7.1	7.0	6.9	6.8	6.8	6.8	6.7
E(t)	158.4	133.0	110.8	109.8	61.3	43.9	43.6	63.1	111.0	110.4	117.0	94.8	90.7	96.8	94.6	63.5	43.3	28.1	55.7	57.2

	1971				1972												1973			
	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A
P(t)	55.4	32.3	68.0	216.7	135.4	137.6	73.0	69.9	35.2	62.1	48.2	51.3	22.9	61.5	134.2	102.6	100.8	72.1	108.1	72.9
PE(t)	154.0	132.8	187.9	156.4	171.3	172.5	142.6	117.2	119.7	100.3	68.1	68.0	137.3	143.3	172.6	168.8	177.0	169.8	166.3	169.0
W(t)	992.4	938.9	936.5	1055.6	1098.2	1130.6	1094.6	1076.3	1039.6	1030.9	1019.8	1030.7	1012.7	995.7	1049.5	1050.9	1052.5	1020.7	1031.9	1008.7
Y(t)	991.8	938.4	936.0	1054.8	1097.3	1129.6	1093.7	1075.4	1038.8	1030.1	1019.1	1029.9	1012.1	995.0	1048.7	1050.1	1051.7	1020.0	1031.2	1008.1
Sw(t)	906.6	868.5	838.9	962.9	993.0	1021.6	1006.4	1004.4	968.8	971.6	979.4	989.9	934.2	915.3	948.3	951.7	948.6	923.8	935.9	913.5
Ro(t)	0.5	0.4	0.4	0.6	0.7	0.7	0.7	0.6	0.5	0.5	0.5	0.5	0.5	0.5	0.6	0.6	0.6	0.5	0.5	0.5
Rg(t)	0.2	0.1	0.1	0.2	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Sg(t)	4806.9	4800.8	4794.7	4788.6	4782.7	4776.7	4770.7	4764.7	4758.7	4752.7	4746.7	4740.8	4734.8	4728.8	4722.8	4716.9	4711.0	4705.0	4699.1	4693.1
Qg(t)	6.3	6.3	6.3	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.1	6.1	6.1	6.1
Q(t)	6.7	6.6	6.6	6.8	6.9	7.0	6.9	6.8	6.7	6.7	6.7	6.7	6.7	6.6	6.7	6.7	6.7	6.6	6.7	6.6
E(t)	85.2	69.9	97.1	91.9	104.3	108.0	87.2	71.0	70.0	58.5	39.7	40.1	77.9	79.7	100.4	98.4	103.1	96.1	95.3	94.6

Appendix D (Continued)

Table D8. (Continued)

	1973								1974											
	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
P(t)	48.9	49.8	34.6	45.5	27.7	83.3	140.9	229.6	161.4	190.3	156.7	210.7	43.9	81.0	28.4	96.5	19.2	199.7	101.6	106.8
PE(t)	87.0	73.6	52.2	63.2	133.8	149.5	130.4	122.8	128.2	122.2	130.2	94.6	100.4	69.0	73.6	91.7	124.6	110.3	155.8	140.3
W(t)	962.4	964.0	957.5	973.7	965.6	975.9	1034.7	1187.9	1266.1	1363.6	1424.2	1527.8	1484.4	1476.9	1443.0	1475.5	1413.9	1511.7	1514.4	1484.9
Y(t)	961.8	963.4	957.0	973.1	965.0	975.3	1034.0	1186.7	1264.4	1361.2	1421.0	1522.2	1480.0	1472.7	1439.5	1471.3	1410.9	1506.6	1509.2	1480.5
Sw(t)	914.2	922.9	928.3	937.9	892.6	893.9	958.3	1104.7	1173.3	1267.6	1317.2	1440.5	1395.9	1414.6	1379.0	1394.7	1312.0	1412.8	1378.1	1364.2
Ro(t)	0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.9	1.2	1.8	2.3	4.1	3.2	3.0	2.5	3.0	2.2	3.7	3.7	3.2
Rg(t)	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.5	0.7	0.9	1.6	1.2	1.2	1.0	1.1	0.8	1.4	1.4	1.2
Sg(t)	4687.2	4681.2	4675.3	4669.4	4663.4	4657.5	4651.7	4646.0	4640.4	4635.0	4629.8	4625.4	4620.5	4615.7	4610.6	4605.8	4600.6	4596.0	4591.5	4586.7
Qg(t)	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Q(t)	6.5	6.5	6.5	6.5	6.5	6.5	6.6	7.0	7.3	7.8	8.4	10.1	9.2	9.0	8.6	9.0	8.2	9.7	9.7	9.1
E(t)	47.6	40.5	28.7	35.2	72.4	81.4	75.7	82.0	91.1	93.6	103.9	81.7	84.1	58.0	60.4	76.6	98.9	93.8	131.1	116.3

	1975												1976							
	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A
P(t)	113.1	77.0	81.5	53.2	60.8	30.7	29.4	51.3	71.7	88.4	119.6	133.4	129.7	104.5	77.9	128.5	41.0	51.7	58.4	37.6
PE(t)	153.4	151.9	144.8	122.6	77.9	76.3	60.1	86.7	108.8	142.6	144.8	165.8	143.3	149.0	123.0	126.4	81.3	62.1	84.9	100.6
W(t)	1477.3	1424.1	1381.9	1320.9	1288.7	1260.4	1233.4	1240.8	1249.9	1260.0	1277.6	1306.0	1313.6	1311.0	1278.0	1316.4	1262.0	1253.7	1266.0	1240.9
Y(t)	1473.1	1420.9	1379.3	1318.8	1286.9	1258.8	1231.9	1239.2	1248.3	1258.4	1275.9	1304.0	1311.6	1309.0	1276.2	1314.4	1260.4	1252.1	1264.3	1239.4
Sw(t)	1347.1	1300.4	1267.7	1227.9	1229.7	1204.0	1189.5	1178.2	1171.6	1158.0	1172.6	1183.9	1206.5	1200.1	1187.9	1221.1	1202.0	1207.6	1203.3	1168.8
Ro(t)	3.0	2.3	1.9	1.5	1.3	1.2	1.1	1.1	1.1	1.2	1.3	1.4	1.4	1.4	1.3	1.5	1.2	1.1	1.2	1.1
Rg(t)	1.2	0.9	0.7	0.6	0.5	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.6	0.5	0.5	0.6	0.5	0.4	0.5	0.4
Sg(t)	4581.9	4576.8	4571.6	4566.2	4560.7	4555.2	4549.7	4544.2	4538.7	4533.2	4527.8	4522.4	4517.1	4511.8	4506.4	4501.0	4495.6	4490.2	4484.8	4479.4
Qg(t)	6.0	6.0	6.0	6.0	6.0	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.8
Q(t)	9.0	8.3	7.9	7.4	7.3	7.1	7.0	7.0	7.1	7.1	7.2	7.3	7.3	7.3	7.1	7.3	7.0	7.0	7.1	6.9
E(t)	126.0	120.4	111.6	91.0	57.1	54.8	42.4	61.1	76.7	100.4	103.3	120.2	105.1	108.9	88.3	93.4	58.4	44.5	61.0	70.6

Appendix D (Continued)

Table D8. (Continued)

	1976 81 S	82 O	83 N	84 D	1977 85 J	86 F	87 M	88 A	89 M	90 J	91 J	92 A	93 S	94 O	95 N	96 D	1978 97 J	98 F	99 M	100 A
P(t)	14.4	189.2	113.1	181.5	130.6	70.0	103.3	149.9	45.8	98.5	90.3	86.7	85.8	17.5	234.5	132.9	126.8	139.8	72.6	44.1
PE(t)	85.9	150.6	147.8	142.1	138.7	139.0	135.2	109.0	73.1	77.8	89.1	76.5	116.3	142.9	133.0	151.9	152.5	154.7	160.3	120.0
W(t)	1183.2	1313.4	1314.3	1385.3	1403.3	1361.6	1356.7	1401.6	1358.3	1397.8	1423.4	1434.9	1454.9	1373.4	1495.8	1512.7	1506.7	1513.7	1451.0	1362.3
Y(t)	1182.0	1311.4	1312.3	1382.7	1400.4	1359.1	1354.3	1398.7	1355.9	1394.9	1420.2	1431.5	1451.1	1370.9	1491.1	1507.6	1501.7	1508.6	1447.4	1359.9
Sw(t)	1124.2	1201.2	1203.9	1272.7	1291.6	1253.4	1251.7	1312.5	1299.3	1333.1	1348.3	1369.1	1356.0	1261.3	1379.9	1379.9	1373.9	1378.5	1318.2	1268.0
Ro(t)	0.9	1.4	1.4	1.9	2.1	1.8	1.7	2.1	1.7	2.1	2.3	2.4	2.7	1.8	3.4	3.7	3.6	3.7	2.6	1.8
Rg(t)	0.3	0.6	0.6	0.7	0.8	0.7	0.7	0.8	0.7	0.8	0.9	0.9	1.0	0.7	1.3	1.4	1.4	1.4	1.0	0.7
Sg(t)	4473.9	4468.6	4463.3	4458.3	4453.3	4448.1	4443.0	4438.0	4432.9	4427.9	4423.0	4418.2	4413.4	4408.4	4403.9	4399.6	4395.3	4390.9	4386.2	4381.2
Qg(t)	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.7	5.7	5.7	5.7	5.7	5.7
Q(t)	6.7	7.3	7.3	7.8	7.9	7.6	7.5	7.9	7.5	7.8	8.1	8.2	8.5	7.6	9.1	9.4	9.3	9.5	8.4	7.5
E(t)	57.7	110.2	108.4	109.9	108.8	105.8	102.6	86.1	56.6	61.8	71.9	62.5	95.2	109.6	111.2	127.8	127.8	130.1	129.1	91.9

	1979 101 M	102 J	103 J	104 A	105 S	106 O	107 N	108 D	1979 109 J	110 F	111 M	112 A	113 M	114 J	115 J	116 A	117 S	118 O	119 N	120 D
P(t)	48.2	41.5	2.0	33.4	143.7	81.6	125.7	299.3	470.5	212.3	169.9	77.1	96.9	15.4	35.5	31.8	57.8	31.4	161.3	103.0
PE(t)	81.9	67.7	102.2	75.3	123.3	161.9	153.8	146.1	140.8	134.4	113.9	87.4	72.7	51.6	67.4	118.0	85.4	151.3	138.7	147.1
W(t)	1316.1	1294.3	1244.4	1204.4	1295.1	1285.1	1293.3	1480.0	1825.7	1782.0	1740.8	1657.8	1656.2	1586.9	1567.2	1531.5	1482.1	1437.4	1474.2	1458.9
Y(t)	1314.1	1292.5	1242.9	1203.1	1293.2	1283.3	1291.5	1475.8	1704.1	1699.0	1689.3	1640.9	1639.6	1578.4	1559.8	1525.8	1477.8	1434.0	1470.1	1455.0
Sw(t)	1252.8	1242.4	1171.0	1151.4	1203.5	1167.7	1180.7	1355.3	1569.8	1571.0	1580.7	1559.3	1571.5	1531.7	1499.7	1424.3	1406.0	1312.9	1355.9	1335.4
Ro(t)	1.5	1.3	1.1	1.0	1.3	1.3	1.3	3.1	88.0	60.1	37.2	12.2	12.0	6.2	5.3	4.2	3.1	2.5	3.0	2.8
Rg(t)	0.6	0.5	0.4	0.4	0.5	0.5	0.5	1.2	33.7	23.0	14.2	4.7	4.6	2.4	2.0	1.6	1.2	0.9	1.1	1.1
Sg(t)	4376.0	4370.9	4365.6	4360.3	4355.1	4349.9	4344.7	4340.3	4368.2	4385.5	4394.0	4393.0	4391.8	4388.5	4384.8	4380.6	4376.1	4371.4	4366.8	4362.2
Qg(t)	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7
Q(t)	7.2	7.0	6.8	6.6	7.0	7.0	7.0	8.7	93.7	65.8	43.0	18.0	17.8	11.9	11.0	9.9	8.8	8.2	8.7	8.4
E(t)	61.3	50.0	71.9	51.7	89.7	115.6	110.7	120.5	134.3	128.0	108.6	81.5	68.1	46.7	60.1	101.5	71.8	121.0	114.2	119.6

Appendix D (Continued)

Table D8. (Continued)

	1980												1981							
	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140
	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A
P(t)	179.4	168.6	222.5	74.5	42.5	105.1	12.3	78.7	30.7	66.2	131.6	118.8	304.1	213.4	148.2	114.3	88.9	16.5	20.1	35.0
PE(t)	130.4	131.4	130.0	98.4	91.0	62.0	61.1	77.1	94.4	128.7	120.2	141.8	129.4	121.8	121.4	110.3	93.2	54.0	58.5	97.1
W(t)	1514.8	1567.7	1667.8	1602.8	1546.7	1565.8	1515.5	1536.1	1493.7	1475.6	1496.6	1509.8	1689.4	1756.5	1726.0	1683.0	1645.3	1560.9	1525.8	1504.2
Y(t)	1509.7	1560.4	1648.7	1593.1	1540.4	1558.6	1510.3	1530.2	1489.1	1471.4	1491.9	1504.7	1664.1	1693.8	1683.8	1659.8	1630.6	1553.9	1520.2	1499.4
Sw(t)	1399.1	1445.3	1528.4	1504.3	1460.8	1503.2	1457.4	1463.0	1409.4	1365.0	1391.0	1385.3	1543.2	1577.8	1568.8	1556.4	1544.4	1505.7	1469.2	1416.9
Ro(t)	3.8	5.3	13.8	7.0	4.6	5.2	3.8	4.3	3.3	3.0	3.4	3.6	18.3	45.3	30.5	16.8	10.6	5.1	4.0	3.5
Rg(t)	1.4	2.0	5.3	2.7	1.8	2.0	1.4	1.6	1.3	1.1	1.3	1.4	7.0	17.3	11.7	6.4	4.1	1.9	1.5	1.3
Sg(t)	4357.9	4354.3	4353.9	4350.9	4347.0	4343.3	4339.1	4335.1	4330.7	4326.2	4321.9	4317.6	4319.0	4330.7	4336.7	4337.5	4335.9	4332.1	4328.0	4323.7
Qg(t)	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.6	5.6	5.6	5.6	5.7	5.7	5.7	5.7	5.7	5.6	5.6
Q(t)	9.4	11.0	19.5	12.7	10.3	10.9	9.4	9.9	9.0	8.6	9.0	9.3	23.9	51.0	36.2	22.5	16.3	10.7	9.7	9.2
E(t)	110.5	115.1	120.3	88.8	79.6	55.3	52.9	67.2	79.7	106.4	101.0	119.4	120.9	116.1	115.0	103.4	86.2	48.2	51.0	82.5

	1982				1982												1983			
	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160
	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A
P(t)	70.1	94.3	99.1	149.1	125.3	256.0	167.2	174.0	140.9	40.9	45.5	44.8	70.8	119.9	127.9	77.3	311.4	126.1	233.9	195.4
PE(t)	103.3	105.1	129.2	120.7	133.9	111.1	113.9	105.1	75.6	61.0	73.2	83.2	97.7	113.9	117.7	130.6	135.2	130.4	121.2	104.4
W(t)	1486.9	1490.1	1496.4	1532.6	1548.2	1682.0	1722.3	1748.1	1731.9	1654.3	1626.3	1591.5	1578.5	1603.5	1619.1	1578.5	1766.8	1693.7	1778.7	1778.0
Y(t)	1482.5	1485.6	1491.8	1526.8	1541.8	1659.1	1682.2	1691.6	1686.2	1638.0	1614.2	1582.7	1570.5	1593.7	1607.9	1570.6	1696.2	1666.9	1698.4	1698.3
Sw(t)	1395.8	1397.4	1383.5	1423.0	1426.0	1555.1	1574.1	1591.0	1613.5	1580.8	1546.7	1507.8	1483.6	1491.3	1501.3	1455.4	1567.6	1544.8	1582.6	1598.0
Ro(t)	3.2	3.3	3.4	4.2	4.6	16.6	29.0	40.9	33.1	11.8	8.7	6.4	5.8	7.1	8.1	5.8	51.1	19.4	58.1	57.6
Rg(t)	1.2	1.2	1.3	1.6	1.8	6.3	11.1	15.6	12.7	4.5	3.3	2.4	2.2	2.7	3.1	2.2	19.5	7.4	22.2	22.0
Sg(t)	4319.3	4314.9	4310.6	4306.6	4302.8	4303.5	4308.9	4318.9	4326.0	4324.8	4322.5	4319.3	4315.9	4313.0	4310.5	4307.1	4321.0	4322.8	4339.3	4355.7
Qg(t)	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.7	5.7
Q(t)	8.8	8.9	9.0	9.8	10.3	22.2	34.6	46.5	38.7	17.4	14.4	12.0	11.4	12.7	13.8	11.4	56.7	25.1	63.7	63.3
E(t)	86.7	88.3	108.2	103.8	115.8	104.0	108.1	100.5	72.7	57.2	67.4	74.9	87.0	102.4	106.6	115.2	128.6	122.0	115.9	100.3

Appendix D (Continued)

Table D8. (Continued)

	1984 161 M	162 J	163 J	164 A	165 S	166 O	167 N	168 D	1984 169 J	170 F	171 M	172 A	173 M	174 J	175 J	176 A	177 S	178 O	179 N	180 D
P(t)	202.3	42.4	41.5	61.1	56.9	171.1	99.8	247.4	204.1	249.0	178.2	63.6	148.9	139.3	30.4	59.6	58.9	180.1	249.2	227.5
PE(t)	80.8	35.7	51.9	74.1	86.7	118.0	117.2	140.4	119.1	121.2	131.3	82.3	95.4	40.0	75.5	65.6	117.5	155.1	119.4	122.5
W(t)	1800.3	1665.6	1654.7	1650.6	1622.8	1702.8	1660.9	1782.2	1769.6	1831.9	1766.5	1634.8	1694.5	1716.5	1671.2	1639.7	1623.7	1685.3	1766.9	1809.7
Y(t)	1701.5	1647.0	1638.3	1635.0	1611.2	1672.3	1643.4	1699.0	1696.8	1704.6	1696.1	1621.6	1667.4	1679.5	1651.3	1625.8	1612.0	1661.3	1696.2	1702.6
Sw(t)	1623.2	1613.2	1589.5	1565.9	1531.7	1561.1	1534.8	1565.5	1582.9	1588.3	1571.2	1545.6	1577.2	1640.8	1580.1	1564.8	1505.2	1517.7	1582.2	1585.2
Ro(t)	71.5	13.5	11.8	11.3	8.4	22.0	12.7	60.2	52.7	92.1	50.9	9.5	19.6	26.7	14.4	10.0	8.5	17.3	51.1	77.4
Rg(t)	27.3	5.1	4.5	4.3	3.2	8.4	4.9	23.0	20.2	35.2	19.5	3.6	7.5	10.2	5.5	3.8	3.3	6.6	19.6	29.6
Sg(t)	4377.3	4376.7	4375.5	4374.1	4371.7	4374.4	4373.6	4390.9	4405.3	4434.7	4448.4	4446.2	4447.9	4452.3	4452.0	4450.1	4447.5	4448.3	4462.1	4485.9
Qg(t)	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.9
Q(t)	77.2	19.2	17.5	17.0	14.1	27.8	18.4	65.9	58.4	97.9	56.7	15.3	25.4	32.5	20.2	15.8	14.3	23.1	57.0	83.3
E(t)	78.3	33.9	48.8	69.1	79.4	111.2	108.5	133.5	113.8	116.3	125.0	76.0	90.2	38.7	71.1	61.0	106.8	143.6	114.1	117.4

	1985 181 J	182 F	183 M	184 A	185 M	186 J	187 J	188 A	189 S	190 O	191 N	192 D	1986 193 J	194 F	195 M	196 A	197 M	198 J	199 J	200 A
P(t)	354.9	192.5	224.8	208.1	129.3	97.6	118.7	49.5	57.0	129.7	161.2	157.2	296.5	145.7	181.3	71.3	48.0	49.4	45.1	38.4
PE(t)	148.3	147.5	131.9	99.7	95.3	71.4	63.4	69.1	100.8	150.0	157.7	177.0	136.0	127.0	119.2	117.0	88.7	74.7	66.7	87.3
W(t)	1940.1	1760.2	1779.9	1781.0	1732.1	1692.7	1717.0	1668.3	1640.9	1663.7	1668.9	1661.8	1779.4	1714.7	1740.1	1647.0	1572.4	1535.3	1509.3	1485.2
Y(t)	1709.3	1694.7	1698.6	1698.8	1686.3	1666.2	1679.8	1649.1	1626.9	1645.5	1649.5	1644.1	1698.6	1678.7	1689.1	1632.1	1564.8	1529.4	1504.3	1480.9
Sw(t)	1567.7	1555.1	1572.9	1602.9	1595.1	1598.3	1618.8	1584.0	1534.1	1507.8	1504.7	1482.9	1569.0	1558.9	1575.7	1524.4	1485.9	1464.2	1446.9	1407.4
Ro(t)	166.9	47.4	58.8	59.4	33.2	19.2	26.9	13.9	10.1	13.1	14.0	12.9	58.5	26.1	36.9	10.8	5.5	4.3	3.6	3.2
Rg(t)	63.9	18.1	22.5	22.7	12.7	7.3	10.3	5.3	3.9	5.0	5.4	4.9	22.4	10.0	14.1	4.1	2.1	1.6	1.4	1.2
Sg(t)	4543.8	4556.0	4572.5	4589.2	4595.9	4597.3	4601.6	4600.9	4598.8	4597.8	4597.1	4596.1	4612.4	4616.4	4624.4	4622.6	4618.6	4614.2	4609.6	4604.8
Qg(t)	5.9	5.9	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Q(t)	172.9	53.3	64.7	65.4	39.2	25.2	32.9	19.9	16.1	19.1	20.0	18.8	64.5	32.1	42.9	16.9	11.5	10.3	9.6	9.2
E(t)	141.6	139.6	125.7	95.9	91.1	67.9	61.0	65.1	92.9	137.8	144.9	161.2	129.5	119.8	113.4	107.6	78.9	65.2	57.4	73.5

Appendix D (Continued)

Table D8. (Continued)

	1987 201 S	202 O	203 N	204 D	1987 205 J	206 F	207 M	208 A	209 M	210 J	211 J	212 A	213 S	214 O	215 N	216 D	1988 217 J	218 F	219 M	220 A
P(t)	93.0	98.4	213.2	304.7	143.5	74.2	206.5	145.8	35.1	64.3	101.8	17.5	80.1	101.1	141.0	205.7	283.8	231.7	202.3	73.0
PE(t)	87.3	123.5	144.8	153.1	131.5	131.9	135.7	113.0	54.9	60.8	86.9	77.8	115.6	140.6	160.9	131.7	139.0	151.7	143.0	106.7
W(t)	1500.4	1519.9	1622.5	1785.1	1697.8	1620.4	1696.4	1687.4	1591.8	1597.4	1634.6	1558.8	1563.2	1555.7	1568.0	1626.5	1778.8	1798.0	1759.6	1632.0
Y(t)	1495.6	1514.5	1610.8	1699.5	1669.4	1609.0	1668.5	1662.7	1583.0	1588.1	1621.4	1551.9	1556.1	1549.0	1560.6	1614.4	1698.5	1701.3	1694.6	1619.2
Sw(t)	1421.5	1409.3	1480.4	1554.3	1546.2	1490.0	1541.6	1556.7	1533.2	1532.8	1541.3	1483.1	1454.7	1427.1	1420.9	1495.1	1566.3	1557.3	1559.0	1521.6
Ro(t)	3.4	3.9	8.4	61.9	20.6	8.2	20.2	17.8	6.4	6.7	9.5	5.0	5.1	4.9	5.3	8.7	58.1	69.9	47.0	9.2
Rg(t)	1.3	1.5	3.2	23.7	7.9	3.2	7.7	6.8	2.5	2.6	3.6	1.9	2.0	1.9	2.0	3.3	22.2	26.8	18.0	3.5
Sg(t)	4600.1	4595.6	4592.8	4610.5	4612.4	4609.5	4611.2	4612.0	4608.4	4605.0	4602.6	4598.5	4594.5	4590.4	4586.4	4583.8	4600.0	4620.8	4632.7	4630.2
Qg(t)	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Q(t)	9.4	9.9	14.4	67.9	26.6	14.3	26.2	23.8	12.4	12.7	15.5	11.0	11.1	10.9	11.3	14.7	64.1	76.0	53.1	15.3
E(t)	74.2	105.2	130.4	145.1	123.2	119.1	126.9	106.0	49.8	55.3	80.1	68.8	101.4	121.9	139.8	119.3	132.2	144.0	135.6	97.6

	1988 221 M	222 J	223 J	224 A	225 S	226 O	227 N	228 D	1989 229 J	230 F	231 M	232 A	233 M	234 J	235 J	236 A	237 S	238 O	239 N	240 D
P(t)	114.0	57.8	86.0	37.1	97.4	97.5	110.1	217.4	225.7	146.4	135.6	143.4	62.0	112.1	136.9	31.5	36.9	117.2	102.4	246.1
PE(t)	56.0	64.0	48.3	113.8	120.3	151.6	172.9	145.0	139.5	149.7	126.0	104.9	68.7	78.7	63.6	94.4	92.3	147.7	167.6	141.9
W(t)	1635.6	1628.0	1642.5	1620.2	1602.8	1582.7	1551.4	1614.0	1699.0	1686.0	1658.5	1668.5	1613.3	1651.8	1699.6	1641.1	1576.9	1604.0	1565.1	1658.9
Y(t)	1622.3	1615.7	1628.3	1608.8	1593.1	1574.4	1544.8	1603.3	1670.1	1661.8	1641.4	1649.2	1602.7	1636.0	1670.4	1627.0	1569.0	1594.2	1557.9	1641.8
Sw(t)	1570.2	1556.5	1583.1	1505.5	1485.2	1441.3	1396.7	1473.3	1539.6	1522.9	1525.1	1551.3	1539.7	1562.7	1609.6	1540.0	1486.8	1462.7	1412.9	1511.4
Ro(t)	9.6	8.9	10.3	8.2	7.0	6.0	4.7	7.8	20.9	17.5	12.3	13.9	7.7	11.4	21.1	10.2	5.7	7.1	5.2	12.4
Rg(t)	3.7	3.4	3.9	3.1	2.7	2.3	1.8	3.0	8.0	6.7	4.7	5.3	3.0	4.4	8.1	3.9	2.2	2.7	2.0	4.7
Sg(t)	4627.8	4625.2	4623.1	4620.2	4616.9	4613.2	4609.0	4605.9	4607.9	4608.6	4607.3	4606.6	4603.6	4601.9	4604.0	4601.9	4598.0	4594.8	4590.8	4589.5
Qg(t)	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Q(t)	15.6	14.9	16.3	14.3	13.1	12.0	10.8	13.8	26.9	23.5	18.4	19.9	13.7	17.4	27.1	16.2	11.7	13.1	11.2	18.4
E(t)	52.1	59.2	45.2	103.3	107.9	133.1	148.2	130.0	130.5	138.9	116.3	97.9	62.9	73.4	60.8	87.1	82.2	131.5	145.0	130.4

Appendix D (Continued)

Table D8. (Continued)

	1990 241 J	242 F	243 M	244 A	245 M	246 J	247 J	248 A	249 S	250 O	251 N	252 D	1991 253 J	254 F	255 M	256 A	257 M	258 J	259 J	260 A
P(t)	153.6	165.7	127.2	90.2	76.8	27.2	22.9	55.5	40.6	97.9	143.8	215.8	268.1	184.4	198.1	159.8	46.7	94.4	44.6	50.2
PE(t)	134.3	143.5	149.4	125.4	75.3	54.8	49.0	94.4	95.9	149.2	154.3	143.4	140.5	140.6	141.0	115.4	101.4	71.4	65.5	88.1
W(t)	1664.9	1573.8	1480.8	1380.8	1313.0	1245.7	1198.8	1194.2	1145.2	1158.9	1183.5	1272.9	1406.3	1428.7	1458.8	1441.7	1335.8	1312.6	1265.6	1235.8
Y(t)	1524.6	1473.6	1409.9	1331.4	1274.0	1214.7	1172.3	1168.1	1123.0	1135.6	1158.2	1238.9	1352.2	1370.1	1393.4	1380.2	1293.6	1273.7	1232.4	1205.8
Sw(t)	1408.1	1353.6	1290.6	1236.2	1218.5	1175.9	1138.7	1104.6	1061.0	1039.7	1057.2	1138.2	1244.4	1260.7	1281.9	1289.1	1218.2	1221.0	1185.6	1144.5
Ro(t)	108.5	77.5	54.8	38.2	30.2	24.0	20.5	20.2	17.2	18.0	19.5	26.3	41.8	45.3	50.6	47.5	32.6	30.1	25.7	23.2
Rg(t)	31.8	22.7	16.1	11.2	8.8	7.0	6.0	5.9	5.0	5.3	5.7	7.7	12.3	13.3	14.8	13.9	9.6	8.8	7.5	6.8
Sg(t)	4614.9	4631.1	4640.6	4645.3	4647.6	4648.1	4647.6	4647.0	4645.5	4644.3	4643.5	4644.6	4650.4	4657.1	4665.4	4672.8	4675.8	4678.0	4679.0	4679.2
Qg(t)	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.6	6.6	6.6	6.6	6.6	6.6
Q(t)	115.0	84.0	61.3	44.7	36.7	30.5	27.0	26.7	23.7	24.5	26.0	32.8	48.4	51.9	57.1	54.1	39.2	36.7	32.2	29.8
E(t)	116.5	119.9	119.3	95.2	55.5	38.7	33.5	63.4	62.0	95.9	101.0	100.8	107.8	109.4	111.5	91.1	75.4	52.7	46.9	61.3

	1991 261 S	262 O	263 N	264 D	1992 265 J	266 F	267 M	268 A	269 M	270 J	271 J	272 A	273 S	274 O	275 N	276 D	1993 277 J	278 F	279 M	280 A
P(t)	25.6	46.7	181.7	166.4	212.2	282.7	107.7	131.6	158.4	112.3	52.9	41.3	92.6	73.4	148.8	255.2	221.9	146.5	161.1	59.6
PE(t)	113.4	125.9	134.5	135.3	157.9	132.0	132.2	105.0	82.0	75.6	38.9	74.4	86.0	125.6	137.0	152.0	139.1	147.2	155.8	115.4
W(t)	1170.1	1118.3	1200.8	1250.7	1337.5	1462.2	1398.8	1376.5	1406.3	1400.4	1341.4	1310.2	1309.4	1281.3	1305.8	1424.2	1470.9	1438.2	1423.8	1305.5
Y(t)	1146.0	1097.9	1174.1	1219.1	1295.1	1396.0	1346.2	1327.8	1352.2	1347.5	1298.4	1271.5	1270.9	1246.3	1267.8	1366.6	1402.5	1377.6	1366.2	1267.5
Sw(t)	1071.6	1019.1	1084.3	1125.3	1179.5	1291.1	1244.9	1247.9	1288.1	1288.5	1268.9	1216.8	1207.9	1157.0	1169.0	1249.0	1291.7	1262.7	1245.9	1183.9
Ro(t)	18.7	15.7	20.7	24.4	32.8	51.2	40.7	37.6	41.8	41.0	33.3	29.9	29.8	27.1	29.4	44.6	52.9	46.9	44.5	29.4
Rg(t)	5.5	4.6	6.1	7.2	9.6	15.0	11.9	11.0	12.3	12.0	9.8	8.8	8.7	7.9	8.6	13.1	15.5	13.8	13.1	8.6
Sg(t)	4678.1	4676.1	4675.6	4676.2	4679.3	4687.7	4693.0	4697.5	4703.1	4708.5	4711.6	4713.8	4715.9	4717.2	4719.2	4725.6	4734.5	4741.6	4748.0	4749.9
Qg(t)	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.7	6.7	6.7	6.7
Q(t)	25.2	22.3	27.2	31.0	39.4	57.8	47.3	44.2	48.4	47.6	39.9	36.5	36.4	33.7	36.0	51.3	59.5	53.6	51.2	36.1
E(t)	74.4	78.8	89.8	93.8	115.5	104.9	101.3	79.9	64.1	58.9	29.5	54.7	63.0	89.3	98.7	117.5	110.8	114.9	120.3	83.6

Appendix D (Continued)

Table D8. (Continued)

	1994 281 M	282 J	283 J	284 A	285 S	286 O	287 N	288 D	1994 289 J	290 F	291 M	292 A	293 M	294 J	295 J	296 A	297 S	298 O	299 N	300 D
P(t)	83.3	57.6	68.4	95.4	42.3	121.6	191.8	162.7	166.9	250.8	141.1	121.0	107.6	75.2	36.9	55.8	161.6	119.3	78.0	263.4
PE(t)	82.1	79.5	55.7	75.8	92.6	141.0	149.3	146.2	161.4	133.8	130.9	105.4	102.6	77.0	69.0	106.9	145.3	138.6	172.8	157.7
W(t)	1267.1	1232.8	1216.2	1245.0	1203.1	1235.0	1300.4	1319.0	1340.1	1429.9	1407.8	1373.5	1352.8	1306.1	1248.5	1224.3	1283.6	1264.9	1212.8	1333.2
Y(t)	1233.8	1203.1	1188.1	1214.0	1176.2	1205.1	1263.1	1279.2	1297.2	1371.0	1353.4	1325.4	1308.0	1268.1	1217.2	1195.4	1248.4	1231.8	1185.0	1291.4
Sw(t)	1175.3	1147.8	1149.6	1160.8	1113.4	1108.6	1156.3	1173.2	1179.1	1266.7	1252.6	1245.2	1231.0	1211.6	1168.5	1122.1	1145.6	1134.8	1069.9	1176.3
Ro(t)	25.8	23.0	21.7	23.9	20.8	23.1	28.9	30.8	33.1	45.5	42.0	37.2	34.6	29.5	24.2	22.3	27.3	25.6	21.5	32.3
Rg(t)	7.6	6.7	6.4	7.0	6.1	6.8	8.5	9.0	9.7	13.3	12.3	10.9	10.1	8.6	7.1	6.5	8.0	7.5	6.3	9.5
Sg(t)	4750.8	4750.8	4750.5	4750.9	4750.3	4750.4	4752.2	4754.6	4757.6	4764.3	4769.9	4774.1	4777.5	4779.4	4779.8	4779.7	4780.9	4781.7	4781.3	4784.1
Qg(t)	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7
Q(t)	32.5	29.7	28.4	30.6	27.5	29.8	35.6	37.5	39.8	52.2	48.7	43.9	41.3	36.2	30.9	29.0	34.0	32.3	28.2	39.1
E(t)	58.5	55.3	38.5	53.2	62.7	96.5	106.7	106.0	118.1	104.3	100.8	80.2	77.1	56.5	48.7	73.3	102.8	97.0	115.2	115.1
	1995 301 J	302 F	303 M	304 A	305 M	306 J	307 J	308 A	309 S	310 O	311 N	312 D	1996 313 J	314 F	315 M	316 A	317 M	318 J	319 J	320 A
P(t)	106.5	142.8	240.2	26.3	51.6	13.4	73.2	41.8	64.9	48.6	168.0	95.0	163.4	141.4	54.9	57.4	66.2	20.9	14.5	7.7
PE(t)	142.4	138.7	141.9	103.2	83.1	83.7	73.2	90.1	127.6	153.8	169.4	165.5	142.3	134.7	147.8	116.5	91.1	45.9	71.9	112.6
W(t)	1282.8	1289.6	1395.0	1261.2	1207.4	1136.8	1134.5	1107.6	1096.4	1047.7	1109.7	1081.0	1127.2	1158.3	1103.0	1050.3	1031.3	983.5	958.9	915.1
Y(t)	1247.7	1253.6	1343.0	1228.5	1180.1	1115.2	1113.0	1088.0	1077.4	1031.5	1089.9	1063.0	1106.2	1135.1	1083.6	1034.0	1016.0	970.5	946.9	904.7
Sw(t)	1146.8	1154.8	1234.9	1155.8	1123.4	1061.3	1065.9	1031.5	999.1	941.8	986.0	963.8	1016.9	1048.1	992.9	965.1	962.7	944.4	907.4	846.4
Ro(t)	27.2	27.8	40.2	25.3	21.1	16.7	16.6	15.2	14.6	12.5	15.3	13.9	16.2	17.9	15.0	12.6	11.8	10.1	9.3	8.1
Rg(t)	8.0	8.2	11.8	7.4	6.2	4.9	4.9	4.5	4.3	3.7	4.5	4.1	4.8	5.3	4.4	3.7	3.5	3.0	2.7	2.4
Sg(t)	4785.3	4786.8	4791.8	4792.5	4791.9	4790.1	4788.3	4786.0	4783.6	4780.5	4778.3	4775.7	4773.7	4772.3	4769.9	4766.9	4763.7	4760.0	4756.1	4751.7
Qg(t)	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7
Q(t)	33.9	34.6	46.9	32.0	27.8	23.5	23.3	21.9	21.4	19.2	22.0	20.6	22.9	24.6	21.7	19.3	18.5	16.8	16.0	14.7
E(t)	100.8	98.8	108.1	72.8	56.6	53.9	47.2	56.5	78.4	89.7	103.9	99.1	89.3	87.0	90.7	68.9	53.3	26.0	39.5	58.3

Appendix D (Continued)

Table D8. (Continued)

	1996 321 S	322 O	323 N	324 D	1997 325 J	326 F	327 M	328 A	329 M	330 J	331 J	332 A	333 S	334 O	335 N	336 D	1998 337 J	338 F	339 M	340 A
P(t)	99.5	144.6	50.0	230.2	227.1	153.0	94.3	96.3	18.5	25.2	25.5	12.9	48.9	109.8	90.1	103.2	172.1	183.2	147.8	106.9
PE(t)	107.3	123.0	142.7	126.5	100.2	93.3	90.7	84.2	69.1	63.8	56.2	40.6	69.8	81.3	89.3	104.4	186.4	159.6	142.0	128.3
W(t)	945.9	1021.5	986.0	1124.2	1251.0	1302.2	1291.1	1285.6	1207.8	1158.4	1118.6	1075.2	1081.3	1130.0	1146.8	1169.8	1249.1	1273.8	1275.7	1248.2
Y(t)	934.4	1006.7	972.8	1103.4	1219.4	1264.7	1254.9	1250.1	1180.5	1135.2	1098.2	1057.5	1063.3	1108.8	1124.5	1145.7	1217.7	1239.7	1241.4	1216.9
Sw(t)	876.9	936.0	894.0	1023.9	1149.2	1196.8	1189.3	1189.4	1133.2	1093.1	1062.3	1032.4	1020.2	1056.8	1066.6	1077.1	1090.6	1127.9	1141.3	1128.0
Ro(t)	8.9	11.5	10.2	16.0	24.4	29.1	28.0	27.5	21.1	18.0	15.8	13.7	13.9	16.4	17.3	18.6	24.3	26.4	26.6	24.2
Rg(t)	2.6	3.4	3.0	4.7	7.2	8.5	8.2	8.0	6.2	5.3	4.6	4.0	4.1	4.8	5.1	5.5	7.1	7.7	7.8	7.1
Sg(t)	4747.7	4744.4	4740.7	4738.8	4739.3	4741.1	4742.7	4744.1	4743.6	4742.2	4740.1	4737.5	4734.9	4733.1	4731.5	4730.3	4730.8	4731.9	4733.0	4733.5
Qg(t)	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.6	6.6	6.6	6.6	6.6	6.6	6.6
Q(t)	15.6	18.1	16.9	22.7	31.1	35.7	34.6	34.1	27.8	24.6	22.4	20.3	20.6	23.0	23.9	25.3	30.9	33.0	33.2	30.8
E(t)	57.5	70.7	78.8	79.6	70.2	67.9	65.6	60.7	47.3	42.1	35.9	25.1	43.0	52.1	57.9	68.6	127.2	111.7	100.1	88.9

	1998 341 M	342 J	343 J	344 A	345 S	346 O	347 N	348 D	1999 349 J	350 F	351 M	352 A	353 M	354 J	355 J	356 A	357 S	358 O	359 N	360 D
P(t)	31.7	32.7	24.4	33.5	41.9	147.4	235.7	138.4	156.6	138.3	118.9	59.3	34.7	71.9	19.0	12.8	44.0	149.2	87.9	160.6
PE(t)	87.4	74.8	100.4	92.2	93.4	141.8	146.3	157.1	156.0	170.2	139.2	103.7	77.6	59.3	53.6	98.3	170.9	170.4	168.9	148.3
W(t)	1159.7	1111.8	1069.0	1024.5	997.8	1078.5	1211.0	1223.7	1245.4	1245.6	1217.1	1154.2	1098.7	1103.1	1065.3	1028.3	999.9	1040.4	1014.3	1065.3
Y(t)	1136.4	1091.9	1051.7	1009.6	984.1	1060.7	1183.4	1194.9	1214.4	1214.6	1188.9	1131.3	1079.6	1083.7	1048.2	1013.1	986.1	1024.7	999.8	1048.2
Sw(t)	1079.1	1044.6	991.0	955.9	931.2	975.3	1085.3	1088.8	1107.3	1098.2	1095.0	1064.0	1031.2	1046.3	1015.5	955.9	891.2	926.4	904.7	960.1
Ro(t)	18.0	15.4	13.4	11.6	10.6	13.8	21.4	22.3	24.0	24.0	21.8	17.7	14.8	15.0	13.2	11.7	10.7	12.2	11.2	13.2
Rg(t)	5.3	4.5	3.9	3.4	3.1	4.1	6.3	6.5	7.0	7.0	6.4	5.2	4.3	4.4	3.9	3.4	3.1	3.6	3.3	3.9
Sg(t)	4732.1	4730.0	4727.2	4724.0	4720.5	4717.9	4717.5	4717.5	4717.9	4718.3	4718.0	4716.6	4714.3	4712.1	4709.3	4706.2	4702.7	4699.6	4696.3	4693.6
Qg(t)	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6
Q(t)	24.7	22.1	20.0	18.2	17.2	20.4	28.0	28.9	30.6	30.6	28.4	24.3	21.4	21.6	19.8	18.3	17.3	18.8	17.8	19.8
E(t)	57.3	47.2	60.6	53.6	52.9	85.3	98.1	106.1	107.1	116.3	94.0	67.3	48.5	37.4	32.7	57.2	94.8	98.3	95.1	88.0

Appendix D (Continued)

Table D8. (Continued)

	2000 361 J	362 F	363 M	364 A	365 M	366 J	367 J	368 A	369 S	370 O	371 N	372 D	2001 373 J	374 F	375 M	376 A	377 M	378 J	379 J	380 A
P(t)	170.1	60.5	221.2	67.9	43.2	69.4	160.7	73.6	25.9	228.7	295.7	397.0	125.4	104.3	114.4	180.9	228.4	67.1	33.1	38.6
PE(t)	172.5	151.7	126.5	131.5	75.5	73.8	47.3	100.3	110.2	155.1	139.2	136.0	142.6	157.2	133.2	118.7	63.9	59.8	81.3	127.1
W(t)	1130.2	1061.9	1176.5	1136.7	1074.8	1080.4	1177.7	1194.8	1127.2	1265.1	1419.7	1652.2	1526.2	1429.9	1363.7	1398.3	1482.8	1426.1	1353.6	1285.8
Y(t)	1109.1	1045.0	1151.8	1115.0	1057.2	1062.4	1153.0	1168.6	1106.2	1232.0	1362.9	1518.2	1442.3	1371.0	1317.2	1345.7	1411.4	1368.0	1308.7	1250.3
Sw(t)	1001.4	955.3	1068.8	1031.6	1011.0	1017.0	1121.2	1101.3	1036.4	1124.0	1255.2	1400.8	1325.6	1249.3	1217.4	1254.4	1359.0	1320.5	1247.2	1159.8
Ro(t)	16.4	13.1	19.1	16.7	13.7	13.9	19.1	20.2	16.2	25.6	43.9	103.6	64.9	45.5	36.0	40.6	55.2	44.9	34.7	27.5
Rg(t)	4.8	3.8	5.6	4.9	4.0	4.1	5.6	5.9	4.7	7.5	12.9	30.4	19.0	13.3	10.5	11.9	16.2	13.2	10.2	8.1
Sg(t)	4691.8	4689.1	4688.1	4686.4	4683.8	4681.3	4680.4	4679.7	4677.9	4678.8	4685.1	4708.9	4721.3	4728.0	4731.9	4737.1	4746.6	4753.1	4756.6	4758.0
Qg(t)	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.7	6.7	6.7	6.7	6.7
Q(t)	23.0	19.7	25.6	23.3	20.2	20.5	25.7	26.8	22.8	32.2	50.5	110.2	71.5	52.2	42.6	47.3	61.9	51.6	41.4	34.2
E(t)	107.6	89.7	83.1	83.4	46.2	45.4	31.8	67.3	69.8	108.0	107.7	117.4	116.7	121.8	99.8	91.3	52.4	47.5	61.5	90.5

	2001 381 S	382 O	383 N	384 D	2002 385 J	386 F	387 M	388 A	389 M	390 J	391 J	392 A	393 S	394 O	395 N	396 D	2003 397 J	398 F	399 M	400 A
P(t)	114.6	236.9	257.7	89.7	146.4	387.6	89.9	95.2	46.3	90.6	61.5	11.1	27.6	111.6	124.9	153.6	223.2	164.8	132.7	75.6
PE(t)	127.7	154.1	140.5	170.8	178.8	131.7	140.2	112.3	103.4	52.2	59.5	112.8	134.3	175.1	158.2	139.2	149.9	124.1	133.2	114.4
W(t)	1274.4	1386.8	1477.7	1385.0	1353.0	1564.5	1447.6	1369.7	1283.6	1264.8	1255.7	1192.4	1118.8	1126.1	1121.3	1156.1	1266.7	1293.5	1300.8	1243.2
Y(t)	1240.2	1336.4	1407.6	1334.9	1308.2	1467.7	1384.8	1322.2	1248.3	1231.7	1223.7	1166.4	1098.4	1105.2	1100.8	1133.0	1233.4	1257.0	1263.4	1212.4
Sw(t)	1149.9	1220.0	1295.3	1206.6	1176.9	1357.7	1274.5	1237.3	1174.2	1194.2	1181.3	1091.2	1014.5	996.4	1002.5	1043.5	1128.7	1168.1	1167.6	1133.1
Ro(t)	26.4	39.0	54.2	38.8	34.6	74.8	48.5	36.7	27.3	25.6	24.8	20.1	15.8	16.1	15.9	17.8	25.7	28.2	28.9	23.8
Rg(t)	7.7	11.4	15.9	11.4	10.2	21.9	14.2	10.8	8.0	7.5	7.3	5.9	4.6	4.7	4.7	5.2	7.5	8.3	8.5	7.0
Sg(t)	4759.1	4763.8	4773.0	4777.7	4781.1	4796.3	4803.8	4807.8	4809.0	4809.8	4810.3	4809.4	4807.3	4805.3	4803.2	4801.7	4802.5	4804.0	4805.7	4805.9
Qg(t)	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.8	6.8	6.8	6.8	6.8	6.8	6.7	6.7	6.7	6.7	6.7	6.8	6.8
Q(t)	33.1	45.7	60.9	45.5	41.4	81.6	55.3	43.5	34.0	32.3	31.6	26.8	22.5	22.9	22.6	24.6	32.5	35.0	35.7	30.5
E(t)	90.2	116.4	112.2	128.3	131.3	110.0	110.2	85.0	74.1	37.5	42.3	75.3	83.9	108.8	98.3	89.5	104.7	89.0	95.8	79.4

Appendix D (Continued)

Table D8. (Continued)

	2003 401 M	402 J	403 J	404 A	405 S	406 O	407 N	408 D	2004 409 J	410 F	411 M	412 A	413 M	414 J	415 J	416 A	417 S	418 O	419 N	420 D
P(t)	71.3	78.0	19.2	11.1	138.0	134.5	96.4	254.1	92.1	97.8	102.9	47.6	69.5	60.4	37.5	0.5	7.3	232.5	70.0	145.8
PE(t)	103.5	94.4	69.9	85.0	125.5	153.8	161.8	131.9	188.3	158.1	151.6	115.6	51.8	68.9	64.8	98.6	144.4	151.0	145.1	160.0
W(t)	1204.4	1185.4	1116.3	1062.7	1132.5	1166.1	1139.4	1269.6	1235.3	1176.1	1151.6	1079.6	1061.0	1073.0	1050.8	996.1	934.1	1079.9	1041.2	1086.8
Y(t)	1177.4	1160.0	1096.0	1045.8	1111.2	1142.3	1117.5	1236.0	1205.4	1151.5	1128.9	1061.7	1044.1	1055.5	1034.5	982.5	923.0	1061.9	1025.3	1068.4
Sw(t)	1107.4	1097.1	1051.6	994.5	1031.6	1043.0	1015.5	1143.2	1078.3	1048.7	1032.0	991.5	1012.6	1013.3	995.6	926.8	847.4	971.2	941.0	971.9
Ro(t)	20.9	19.6	15.6	13.1	16.5	18.4	16.9	26.0	23.2	19.0	17.6	13.9	13.0	13.6	12.6	10.5	8.6	13.9	12.2	14.2
Rg(t)	6.1	5.8	4.6	3.8	4.8	5.4	4.9	7.6	6.8	5.6	5.1	4.1	3.8	4.0	3.7	3.1	2.5	4.1	3.6	4.2
Sg(t)	4805.3	4804.3	4802.2	4799.3	4797.4	4796.0	4794.2	4795.1	4795.2	4794.0	4792.4	4789.8	4786.9	4784.1	4781.1	4777.5	4773.3	4770.7	4767.6	4765.0
Qg(t)	6.8	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7
Q(t)	27.6	26.4	22.4	19.9	23.2	25.2	23.6	32.7	29.9	25.8	24.3	20.6	19.8	20.3	19.3	17.3	15.3	20.6	18.9	20.9
E(t)	69.9	63.0	44.4	51.3	79.5	99.4	102.0	92.8	127.1	102.8	96.8	70.2	31.5	42.2	38.9	55.7	75.6	90.8	84.3	96.5

	2005 421 J	422 F	423 M	424 A	425 M	426 J	427 J	428 A	429 S	430 O	431 N	432 D	2006 433 J	434 F	435 M	436 A	437 M	438 J	439 J	440 A
P(t)	163.3	56.2	117.1	60.6	61.4	93.3	3.0	73.1	87.5	178.9	242.6	200.1	104.1	110.6	227.4	126.1	33.2	75.4	42.7	1.2
PE(t)	168.6	169.8	151.0	107.5	85.4	78.5	67.5	104.9	79.9	121.3	147.2	155.4	150.9	157.9	139.7	124.7	67.2	81.7	94.0	109.4
W(t)	1135.2	1064.2	1064.2	1018.2	1003.2	1033.8	975.1	997.9	1012.4	1130.9	1275.4	1337.7	1285.6	1253.9	1340.4	1320.7	1222.8	1222.9	1180.5	1094.3
Y(t)	1113.7	1047.1	1047.1	1003.6	989.2	1018.3	962.4	984.1	998.0	1109.6	1241.1	1295.2	1250.1	1222.0	1297.6	1280.7	1194.1	1194.2	1155.5	1075.4
Sw(t)	1008.0	947.1	957.6	941.8	940.5	972.1	924.8	924.9	952.0	1032.8	1137.6	1181.5	1143.3	1113.0	1194.6	1189.6	1147.5	1137.8	1093.1	1008.0
Ro(t)	16.6	13.2	13.2	11.3	10.8	11.9	9.8	10.6	11.1	16.4	26.5	32.8	27.5	24.7	33.2	31.0	22.2	22.2	19.3	14.5
Rg(t)	4.9	3.9	3.9	3.3	3.2	3.5	2.9	3.1	3.3	4.8	7.8	9.6	8.0	7.2	9.7	9.1	6.5	6.5	5.7	4.3
Sg(t)	4763.2	4760.4	4757.6	4754.2	4750.7	4747.6	4743.8	4740.2	4736.8	4735.0	4736.1	4739.1	4740.5	4741.0	4744.1	4746.5	4746.4	4746.2	4745.2	4742.8
Qg(t)	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7
Q(t)	23.3	19.9	19.9	18.0	17.5	18.6	16.5	17.3	17.8	23.1	33.2	39.5	34.1	31.3	39.8	37.6	28.9	28.9	26.0	21.2
E(t)	105.8	100.1	89.5	61.8	48.7	46.2	37.7	59.2	46.1	76.8	103.5	113.8	106.8	109.0	102.9	91.1	46.5	56.4	62.5	67.4

Appendix D (Continued)

Table D8. (Continued)

	2006				2007												2008			
	441	442	443	444	445	446	447	448	449	450	451	452	453	454	455	456	457	458	459	460
	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A
P(t)	97.2	18.1	89.1	255.6	323.0	179.4	92.6	77.6	132.0	66.8	16.1	20.3	74.6	67.7	296.9	204.0	380.2	227.7	194.0	133.9
PE(t)	118.5	153.2	161.8	149.1	135.6	140.6	135.9	131.6	63.8	83.5	62.3	74.1	157.1	158.7	129.2	143.8	137.8	140.6	134.8	105.7
W(t)	114.7	39.2	100.2	274.2	324.2	169.3	110.3	97.8	151.9	89.8	37.9	33.8	86.5	85.6	314.7	196.1	394.8	199.5	208.3	147.1
Y(t)	28.2	16.1	27.6	1.8	-14.1	25.0	28.1	27.4	26.9	26.7	15.7	14.3	26.3	26.2	-10.9	20.8	-39.6	20.2	18.4	27.3
Sw(t)	21.1	11.1	18.6	1.2	-10.1	17.7	20.2	19.9	23.0	21.8	13.5	11.9	17.9	17.8	-7.9	14.6	-28.2	14.3	13.2	21.1
Ro(t)	51.0	13.6	42.8	160.7	199.6	85.1	48.5	41.5	73.7	37.2	13.1	11.5	35.5	35.0	192.1	103.4	256.3	105.8	112.0	70.7
Rg(t)	35.4	9.5	29.8	111.7	138.7	59.2	33.7	28.8	51.2	25.9	9.1	8.0	24.7	24.4	133.5	71.9	178.1	73.5	77.8	49.1
Sg(t)	82.1	66.4	69.7	131.4	195.7	184.7	158.3	135.6	135.4	116.8	91.3	71.9	70.0	68.4	146.3	158.1	243.6	229.8	222.9	197.1
Qg(t)	31.2	25.2	26.5	49.9	74.4	70.2	60.1	51.5	51.4	44.4	34.7	27.3	26.6	26.0	55.6	60.1	92.6	87.3	84.7	74.9
Q(t)	82.2	38.8	69.3	210.6	274.0	155.3	108.6	93.0	125.2	81.6	47.8	38.8	62.1	61.0	247.7	163.5	348.9	193.1	196.7	145.6
E(t)																				

	2008								2009											
	461	462	463	464	465	466	467	468	469	470	471	472	473	474	475	476	477	478	479	480
	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
P(t)	56.0	33.4	70.8	50.4	80.7	164.0	72.9	133.1	217.2	173.9	249.2	103.9	106.4	28.3	80.2	43.9	56.2	93.7	173.0	150.8
PE(t)	78.0	47.2	105.0	105.2	114.6	139.8	175.6	168.2	150.9	145.7	146.3	143.8	93.0	62.9	63.9	100.5	112.7	144.5	164.6	145.6
W(t)	1375.1	1300.3	1299.0	1236.2	1214.1	1272.4	1213.0	1201.4	1280.6	1313.2	1418.1	1352.7	1307.7	1229.7	1236.6	1205.7	1166.7	1162.9	1218.9	1230.9
Y(t)	1326.7	1262.9	1261.8	1206.1	1186.2	1238.5	1185.2	1174.6	1245.7	1274.1	1361.7	1308.0	1269.4	1200.3	1206.5	1178.6	1142.9	1139.3	1190.6	1201.4
Sw(t)	1266.9	1228.2	1185.8	1133.4	1108.4	1140.1	1068.3	1063.4	1139.3	1168.9	1248.8	1201.3	1201.4	1156.4	1161.8	1110.5	1069.2	1045.9	1080.1	1102.2
Ro(t)	37.4	28.9	28.7	23.2	21.6	26.3	21.5	20.7	27.0	30.2	43.6	34.6	29.6	22.7	23.3	21.0	18.5	18.2	21.9	22.8
Rg(t)	11.0	8.5	8.4	6.8	6.3	7.7	6.3	6.1	7.9	8.8	12.8	10.1	8.7	6.7	6.8	6.2	5.4	5.3	6.4	6.7
Sg(t)	4787.6	4789.4	4791.1	4791.2	4790.8	4791.7	4791.3	4790.6	4791.8	4793.9	4800.0	4803.4	4805.3	4805.2	4805.3	4804.7	4803.4	4802.0	4801.6	4801.6
Qg(t)	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.8	6.7	6.7	6.7	6.7	6.7	6.7	6.7
Q(t)	44.2	35.6	35.5	30.0	28.3	33.0	28.2	27.4	33.7	36.9	50.4	41.4	36.4	29.5	30.0	27.7	25.2	25.0	28.7	29.6
E(t)	59.8	34.8	76.0	72.8	77.8	98.3	117.0	111.2	106.4	105.2	112.9	106.7	68.0	43.9	44.7	68.0	73.7	93.4	110.5	99.2

Appendix D (Continued)

Table D9. Water balance output values – moderate growth and A2 scenarios (2010-2050).

	2010 481 J	482 F	483 M	484 A	485 M	486 J	487 J	488 A	489 S	490 O	491 N	492 D	2011 493 J	494 F	495 M	496 A	497 M	498 J	499 J	500 A
P(t)	292.8	199.5	119.7	100.3	83.1	7.1	55.2	46.8	74.6	113.4	154.9	188.8	198.1	157.8	143.8	101.2	76.4	57.6	48.5	41.8
PE(t)	144.0	145.2	172.7	120.1	74.6	82.2	63.8	87.3	108.4	138.6	145.4	144.0	144.4	145.9	173.4	120.7	74.9	82.5	64.0	87.6
W(t)	1395.0	1432.9	1380.1	1301.9	1260.7	1182.1	1157.3	1139.0	1135.5	1158.2	1200.5	1265.9	1330.2	1307.4	1276.2	1192.9	1139.4	1106.4	1065.0	1034.3
Y(t)	1343.1	1373.4	1330.8	1264.3	1228.1	1157.0	1134.2	1117.2	1114.0	1135.0	1173.8	1232.7	1253.8	1236.2	1211.5	1142.9	1097.0	1068.2	1031.4	1003.8
Sw(t)	1233.4	1260.4	1201.6	1177.6	1175.0	1102.1	1092.2	1061.0	1044.8	1045.6	1077.1	1132.1	1149.6	1132.5	1091.7	1063.0	1048.8	1016.5	992.6	952.4
Ro(t)	40.2	46.0	38.1	29.0	25.2	19.4	17.9	16.8	16.7	17.9	20.6	25.7	62.9	58.6	53.3	41.2	34.9	31.5	27.6	25.1
Rg(t)	11.8	13.5	11.2	8.5	7.4	5.7	5.2	4.9	4.9	5.3	6.0	7.5	13.5	12.6	11.4	8.8	7.5	6.8	5.9	5.4
Sg(t)	4806.6	4813.3	4817.8	4819.5	4820.1	4819.0	4817.5	4815.7	4813.8	4812.3	4811.6	4812.4	4818.6	4823.9	4828.1	4829.7	4829.9	4829.4	4828.1	4826.2
Qg(t)	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3
Q(t)	46.9	52.8	44.9	35.8	32.0	26.2	24.7	23.6	23.4	24.7	27.4	32.4	70.2	65.9	60.5	48.4	42.1	38.7	34.9	32.3
E(t)	109.7	113.0	129.2	86.7	53.0	54.9	42.0	56.2	69.2	89.4	96.7	100.6	104.1	103.7	119.8	79.9	48.2	51.6	38.9	51.5
	2011 501 S	502 O	503 N	504 D	2012 505 J	506 F	507 M	508 A	509 M	510 J	511 J	512 A	513 S	514 O	515 N	516 D	2013 517 J	518 F	519 M	520 A
P(t)	61.6	113.6	147.4	183.5	199.8	158.2	144.4	101.4	76.3	57.6	48.5	41.8	61.5	112.9	144.3	184.1	201.6	158.5	145.0	101.7
PE(t)	109.0	139.8	146.5	144.4	144.8	146.7	174.1	121.3	75.2	82.8	64.2	88.0	109.7	141.0	147.7	144.9	145.3	147.5	174.8	121.9
W(t)	1014.0	1036.6	1072.3	1134.1	1201.5	1212.5	1206.0	1140.8	1097.4	1071.0	1035.0	1008.3	991.3	1016.1	1051.5	1116.9	1189.2	1203.1	1198.9	1135.2
Y(t)	985.4	1005.9	1038.0	1092.4	1150.1	1159.3	1153.9	1098.2	1060.3	1036.8	1004.5	980.2	964.7	987.4	1019.3	1077.4	1139.8	1151.5	1147.9	1093.4
Sw(t)	923.0	924.9	950.6	1001.6	1054.3	1061.6	1039.3	1021.1	1013.4	986.6	966.5	929.8	903.2	907.2	932.8	987.6	1044.6	1053.9	1033.5	1016.2
Ro(t)	23.5	25.3	28.3	34.3	42.3	43.7	42.9	35.0	30.6	28.2	25.1	23.1	21.9	23.7	26.5	32.5	40.7	42.5	41.9	34.4
Rg(t)	5.0	5.4	6.1	7.4	9.1	9.4	9.2	7.5	6.6	6.0	5.4	5.0	4.7	5.1	5.7	7.0	8.7	9.1	9.0	7.4
Sg(t)	4824.0	4822.1	4821.0	4821.1	4822.9	4825.0	4826.9	4827.2	4826.5	4825.3	4823.4	4821.1	4818.6	4816.4	4814.8	4814.6	4816.1	4817.9	4819.7	4819.8
Qg(t)	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.2	7.2	7.2	7.2	7.2	7.3	7.3
Q(t)	30.8	32.5	35.5	41.6	49.5	51.0	50.1	42.3	37.9	35.4	32.4	30.3	29.1	30.9	33.7	39.8	48.0	49.7	49.2	41.7
E(t)	62.5	81.0	87.4	90.8	95.8	97.8	114.5	77.1	46.8	50.3	38.0	50.4	61.5	80.2	86.5	89.8	95.2	97.6	114.4	77.2

Appendix D (Continued)

Table D9. (Continued)

	2013 521 M	522 J	523 J	524 A	525 S	526 O	527 N	528 D	2014 529 J	530 F	531 M	532 A	533 M	534 J	535 J	536 A	537 S	538 O	539 N	540 D
P(t)	76.3	57.6	48.5	41.8	61.4	112.2	141.2	184.7	203.4	158.9	145.7	101.9	76.2	57.7	48.5	41.8	61.3	111.5	138.3	185.3
PE(t)	75.5	83.1	64.5	88.3	110.4	142.2	148.9	145.4	145.7	148.3	175.6	122.4	75.9	83.3	64.7	88.7	111.0	143.4	150.1	145.8
W(t)	1092.5	1066.7	1031.2	1004.8	988.0	1012.2	1044.6	1111.1	1186.1	1200.7	1197.2	1133.7	1090.9	1065.2	1029.7	1003.4	986.5	1009.9	1038.9	1106.4
Y(t)	1055.9	1033.0	1001.0	977.1	961.7	983.8	1013.1	1072.3	1137.1	1149.5	1146.5	1092.1	1054.5	1031.6	999.7	975.8	960.3	981.7	1008.0	1068.2
Sw(t)	1009.1	982.7	963.0	926.6	900.1	903.3	926.4	982.7	1041.8	1051.5	1031.8	1014.7	1007.5	981.2	961.6	925.2	898.4	900.7	921.1	978.6
Ro(t)	30.1	27.8	24.8	22.8	21.6	23.4	25.9	31.9	40.3	42.2	41.7	34.3	30.0	27.7	24.7	22.7	21.5	23.2	25.5	31.5
Rg(t)	6.5	6.0	5.3	4.9	4.6	5.0	5.6	6.9	8.7	9.1	9.0	7.4	6.4	5.9	5.3	4.9	4.6	5.0	5.5	6.8
Sg(t)	4819.0	4817.8	4815.8	4813.5	4810.9	4808.7	4807.0	4806.7	4808.1	4809.9	4811.6	4811.7	4810.9	4809.6	4807.7	4805.3	4802.7	4800.5	4798.7	4798.3
Qg(t)	7.3	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2
Q(t)	37.4	35.0	32.1	30.1	28.9	30.6	33.1	39.2	47.5	49.4	49.0	41.5	37.2	34.9	32.0	30.0	28.8	30.4	32.7	38.7
E(t)	46.8	50.3	38.0	50.5	61.7	80.5	86.6	89.6	95.3	97.9	114.7	77.4	47.0	50.4	38.1	50.6	61.9	81.0	86.9	89.6

	2015 541 J	542 F	543 M	544 A	545 M	546 J	547 J	548 A	549 S	550 O	551 N	552 D	2016 553 J	554 F	555 M	556 A	557 M	558 J	559 J	560 A
P(t)	205.2	159.3	146.3	102.2	76.2	57.7	48.5	41.9	61.2	110.7	135.3	185.9	207.0	159.6	146.9	102.5	76.1	57.7	48.5	41.9
PE(t)	146.2	149.1	176.4	123.0	76.2	83.6	64.9	89.0	111.7	144.7	151.3	146.3	146.6	149.9	177.1	123.6	76.5	83.9	65.2	89.4
W(t)	1183.8	1199.0	1196.0	1132.6	1089.6	1063.9	1028.5	1002.2	985.1	1007.6	1033.4	1101.8	1181.6	1197.4	1194.9	1131.6	1088.3	1062.6	1027.2	1001.0
Y(t)	1135.2	1148.1	1145.5	1091.1	1053.3	1030.5	998.5	974.7	959.1	979.6	1003.1	1064.2	1133.3	1146.7	1144.6	1090.2	1052.2	1029.3	997.4	973.6
Sw(t)	1039.8	1049.7	1030.4	1013.4	1006.2	980.0	960.4	923.9	896.9	898.1	915.9	974.6	1037.8	1048.0	1029.1	1012.2	1004.9	978.7	959.1	922.7
Ro(t)	40.0	42.0	41.6	34.1	29.9	27.5	24.6	22.7	21.4	23.0	25.0	31.0	39.8	41.8	41.4	34.0	29.7	27.4	24.5	22.6
Rg(t)	8.6	9.0	8.9	7.3	6.4	5.9	5.3	4.9	4.6	4.9	5.4	6.7	8.5	9.0	8.9	7.3	6.4	5.9	5.3	4.8
Sg(t)	4799.6	4801.4	4803.1	4803.2	4802.4	4801.1	4799.1	4796.8	4794.2	4791.9	4790.1	4789.5	4790.9	4792.6	4794.3	4794.4	4793.5	4792.2	4790.3	4787.9
Qg(t)	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2
Q(t)	47.2	49.2	48.8	41.4	37.1	34.8	31.8	29.9	28.7	30.3	32.2	38.2	47.0	49.0	48.6	41.2	36.9	34.6	31.7	29.8
E(t)	95.4	98.3	115.1	77.7	47.1	50.5	38.2	50.7	62.2	81.5	87.1	89.5	95.5	98.7	115.5	78.0	47.2	50.6	38.3	50.9

Appendix D (Continued)

Table D9. (Continued)

	2016 561 S	562 O	563 N	564 D	2017 565 J	566 F	567 M	568 A	569 M	570 J	571 J	572 A	573 S	574 O	575 N	576 D	2018 577 J	578 F	579 M	580 A
P(t)	61.1	110.0	132.5	186.5	208.8	160.0	147.6	102.7	76.0	57.7	48.5	41.9	61.0	109.3	129.7	187.1	210.6	160.3	148.2	103.0
PE(t)	112.4	145.9	152.5	146.8	147.1	150.7	177.9	124.2	76.8	84.2	65.4	89.8	113.1	147.2	153.8	147.3	147.5	151.6	178.7	124.9
W(t)	983.8	1005.4	1028.0	1097.3	1179.5	1195.8	1193.8	1130.5	1087.0	1061.4	1026.0	999.8	982.4	1003.1	1022.7	1092.8	1177.4	1194.3	1192.8	1129.5
Y(t)	957.8	977.6	998.2	1060.1	1131.5	1145.4	1143.7	1089.3	1051.1	1028.2	996.3	972.5	956.6	975.5	993.3	1056.2	1129.7	1144.1	1142.8	1088.4
Sw(t)	895.3	895.5	910.8	970.7	1035.9	1046.2	1027.8	1011.0	1003.7	977.5	957.9	921.5	893.8	893.0	905.7	966.7	1033.9	1044.5	1026.5	1009.8
Ro(t)	21.4	22.9	24.6	30.6	39.5	41.5	41.3	33.9	29.6	27.3	24.4	22.5	21.3	22.7	24.2	30.2	39.2	41.3	41.2	33.8
Rg(t)	4.6	4.9	5.3	6.6	8.5	8.9	8.9	7.3	6.4	5.9	5.2	4.8	4.6	4.9	5.2	6.5	8.4	8.9	8.8	7.3
Sg(t)	4785.3	4783.0	4781.1	4780.5	4781.7	4783.5	4785.1	4785.2	4784.4	4783.0	4781.1	4778.7	4776.1	4773.8	4771.8	4771.1	4772.3	4774.0	4775.7	4775.7
Qg(t)	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2
Q(t)	28.6	30.1	31.8	37.8	46.7	48.7	48.5	41.1	36.8	34.5	31.6	29.7	28.4	29.9	31.4	37.3	46.4	48.5	48.3	41.0
E(t)	62.5	82.0	87.4	89.5	95.7	99.1	115.9	78.3	47.4	50.7	38.4	51.0	62.8	82.5	87.6	89.4	95.8	99.5	116.3	78.6

	2018 581 M	582 J	583 J	584 A	585 S	586 O	587 N	588 D	2019 589 J	590 F	591 M	592 A	593 M	594 J	595 J	596 A	597 S	598 O	599 N	600 D
P(t)	76.0	57.7	48.5	41.9	60.8	108.6	127.0	187.7	212.5	160.7	148.9	103.2	75.9	57.8	48.5	42.0	60.7	107.9	124.3	188.3
PE(t)	77.2	84.5	65.6	90.1	113.8	148.5	155.1	147.8	148.0	152.4	179.5	125.5	77.5	84.8	65.9	90.5	114.5	149.9	156.4	148.3
W(t)	1085.8	1060.1	1024.7	998.6	981.1	1000.9	1017.4	1088.3	1175.3	1192.8	1191.7	1128.4	1084.5	1058.9	1023.5	997.4	979.7	998.6	1012.1	1083.9
Y(t)	1049.9	1027.1	995.2	971.4	955.4	973.5	988.5	1052.2	1128.0	1142.8	1141.9	1087.5	1048.8	1025.9	994.0	970.3	954.1	971.4	983.7	1048.2
Sw(t)	1002.4	976.2	956.7	920.2	892.3	890.4	900.6	962.8	1032.0	1042.8	1025.2	1008.6	1001.1	975.0	955.5	919.0	890.7	887.8	895.5	958.9
Ro(t)	29.5	27.2	24.3	22.4	21.2	22.6	23.8	29.7	39.0	41.2	41.0	33.7	29.4	27.1	24.2	22.3	21.1	22.4	23.4	29.3
Rg(t)	6.3	5.8	5.2	4.8	4.5	4.8	5.1	6.4	8.4	8.8	8.8	7.2	6.3	5.8	5.2	4.8	4.5	4.8	5.0	6.3
Sg(t)	4774.9	4773.6	4771.6	4769.2	4766.6	4764.3	4762.2	4761.4	4762.6	4764.3	4765.9	4766.0	4765.1	4763.8	4761.8	4759.4	4756.8	4754.5	4752.3	4751.5
Qg(t)	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.1
Q(t)	36.7	34.4	31.5	29.6	28.3	29.7	30.9	36.9	46.2	48.3	48.2	40.9	36.6	34.3	31.4	29.5	28.2	29.5	30.5	36.5
E(t)	47.5	50.8	38.5	51.2	63.1	83.1	87.9	89.4	95.9	100.0	116.7	78.9	47.7	51.0	38.6	51.3	63.4	83.6	88.2	89.3

Appendix D (Continued)

Table D9. (Continued)

	2020 601 J	602 F	603 M	604 A	605 M	606 J	607 J	608 A	609 S	610 O	611 N	612 D	2021 613 J	614 F	615 M	616 A	617 M	618 J	619 J	620 A
P(t)	214.4	161.1	149.6	103.5	75.9	57.8	48.5	42.0	60.6	107.2	121.7	188.9	216.3	161.4	150.2	103.7	75.8	57.8	48.5	42.0
PE(t)	148.5	153.3	180.2	126.1	77.9	85.2	66.1	90.9	115.2	151.2	157.7	148.8	149.0	154.2	181.1	126.8	78.2	85.5	66.4	91.3
W(t)	1173.3	1191.2	1190.7	1127.4	1083.2	1057.6	1022.2	996.2	978.3	996.4	1006.9	1079.4	1171.3	1189.8	1189.6	1126.4	1082.0	1056.3	1020.9	995.0
Y(t)	1126.2	1141.5	1141.0	1086.6	1047.7	1024.8	992.9	969.2	952.9	969.4	979.0	1044.3	1124.5	1140.2	1140.1	1085.7	1046.6	1023.7	991.7	968.1
Sw(t)	1030.2	1041.1	1023.9	1007.4	999.8	973.7	954.2	917.7	889.2	885.2	890.5	955.0	1028.3	1039.4	1022.7	1006.2	998.5	972.5	953.0	916.5
Ro(t)	38.7	41.0	40.9	33.6	29.3	27.0	24.1	22.2	21.0	22.2	23.0	28.9	38.5	40.8	40.8	33.5	29.1	26.9	24.0	22.1
Rg(t)	8.3	8.8	8.8	7.2	6.3	5.8	5.2	4.8	4.5	4.8	4.9	6.2	8.3	8.8	8.7	7.2	6.3	5.8	5.2	4.8
Sg(t)	4752.6	4754.3	4755.9	4755.9	4755.1	4753.7	4751.7	4749.4	4746.7	4744.4	4742.2	4741.2	4742.4	4744.0	4745.6	4745.6	4744.8	4743.4	4741.4	4739.0
Qg(t)	7.2	7.2	7.2	7.2	7.2	7.2	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1
Q(t)	45.9	48.1	48.0	40.8	36.4	34.2	31.3	29.4	28.1	29.4	30.1	36.1	45.6	47.9	47.9	40.6	36.3	34.0	31.2	29.3
E(t)	96.1	100.4	117.1	79.3	47.9	51.1	38.7	51.5	63.7	84.1	88.4	89.3	96.2	100.8	117.5	79.6	48.0	51.2	38.8	51.6

	2021 621 S	622 O	623 N	624 D	2022 625 J	626 F	627 M	628 A	629 M	630 J	631 J	632 A	633 S	634 O	635 N	636 D	2023 637 J	638 F	639 M	640 A
P(t)	60.5	106.5	119.1	189.5	218.2	161.8	150.9	104.0	75.7	57.8	48.5	42.0	60.4	105.8	116.6	190.1	220.1	162.2	151.5	104.3
PE(t)	115.9	152.6	159.0	149.3	149.4	155.0	181.9	127.4	78.6	85.8	66.6	91.7	116.7	154.0	160.4	149.8	149.9	155.9	182.7	128.0
W(t)	977.0	994.1	1001.7	1075.0	1169.3	1188.3	1188.6	1125.4	1080.7	1055.1	1019.7	993.8	975.6	991.9	996.6	1070.7	1167.4	1186.9	1187.6	1124.4
Y(t)	951.6	967.3	974.2	1040.4	1122.9	1139.0	1139.3	1084.9	1045.4	1022.5	990.6	967.0	950.3	965.2	969.6	1036.5	1121.2	1137.8	1138.4	1084.0
Sw(t)	887.6	882.6	885.5	951.2	1026.5	1037.7	1021.4	1005.0	997.3	971.2	951.7	915.2	886.0	880.0	880.5	947.3	1024.7	1036.1	1020.1	1003.7
Ro(t)	20.9	22.1	22.6	28.5	38.3	40.6	40.6	33.4	29.0	26.8	23.9	22.0	20.8	21.9	22.2	28.1	38.0	40.4	40.5	33.3
Rg(t)	4.5	4.7	4.9	6.1	8.2	8.7	8.7	7.2	6.2	5.7	5.1	4.7	4.5	4.7	4.8	6.0	8.2	8.7	8.7	7.1
Sg(t)	4736.4	4734.0	4731.7	4730.7	4731.8	4733.4	4735.0	4735.1	4734.2	4732.8	4730.8	4728.4	4725.8	4723.4	4721.1	4720.0	4721.1	4722.6	4724.2	4724.2
Qg(t)	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1
Q(t)	28.0	29.2	29.7	35.6	45.4	47.7	47.8	40.5	36.2	33.9	31.1	29.2	27.9	29.0	29.4	35.2	45.2	47.5	47.6	40.4
E(t)	64.0	84.7	88.7	89.2	96.4	101.3	117.9	79.9	48.2	51.3	38.9	51.8	64.3	85.3	89.0	89.2	96.5	101.7	118.3	80.2

Appendix D (Continued)

Table D9. (Continued)

	2023								2024											
	641	642	643	644	645	646	647	648	649	650	651	652	653	654	655	656	657	658	659	660
	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
P(t)	75.7	57.9	48.5	42.1	60.3	105.2	114.1	190.7	222.1	162.6	152.2	104.5	75.6	57.9	48.5	42.1	60.2	104.5	111.7	191.4
PE(t)	78.9	86.1	66.9	92.1	117.4	155.4	161.8	150.3	150.4	156.8	183.5	128.7	79.3	86.4	67.1	92.4	118.2	156.9	163.2	150.9
W(t)	1079.4	1053.8	1018.4	992.6	974.2	989.6	991.5	1066.3	1165.5	1185.5	1186.6	1123.4	1078.2	1052.6	1017.2	991.3	972.8	987.3	986.4	1062.0
Y(t)	1044.3	1021.4	989.5	965.9	949.1	963.2	964.9	1032.6	1119.6	1136.6	1137.6	1083.1	1043.2	1020.3	988.3	964.8	947.8	961.1	960.3	1028.7
Sw(t)	996.0	970.0	950.5	913.9	884.4	877.4	875.6	943.5	1022.9	1034.4	1018.9	1002.5	994.7	968.7	949.2	912.7	882.9	874.7	870.6	939.6
Ro(t)	28.9	26.7	23.9	22.0	20.7	21.8	21.9	27.8	37.8	40.2	40.4	33.2	28.8	26.6	23.8	21.9	20.6	21.6	21.5	27.4
Rg(t)	6.2	5.7	5.1	4.7	4.4	4.7	4.7	6.0	8.1	8.6	8.7	7.1	6.2	5.7	5.1	4.7	4.4	4.6	4.6	5.9
Sg(t)	4723.3	4722.0	4720.0	4717.6	4715.0	4712.5	4710.1	4709.0	4710.0	4711.6	4713.2	4713.2	4712.3	4710.9	4708.9	4706.5	4703.9	4701.4	4699.0	4697.8
Qg(t)	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1
Q(t)	36.0	33.8	31.0	29.1	27.8	28.8	29.0	34.8	44.9	47.3	47.5	40.3	35.9	33.7	30.8	29.0	27.7	28.7	28.6	34.4
E(t)	48.3	51.5	39.0	51.9	64.6	85.8	89.3	89.1	96.7	102.2	118.7	80.6	48.5	51.6	39.1	52.1	64.9	86.4	89.6	89.1
	2025												2026							
	661	662	663	664	665	666	667	668	669	670	671	672	673	674	675	676	677	678	679	680
	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A
P(t)	224.0	162.9	152.9	104.8	75.6	57.9	48.5	42.1	60.1	103.8	109.4	192.0	226.0	163.3	153.5	105.1	75.5	57.9	48.5	42.1
PE(t)	150.9	157.7	184.4	129.4	79.6	86.7	67.4	92.8	118.9	158.3	164.6	151.4	151.4	158.7	185.2	130.0	80.0	87.1	67.7	93.3
W(t)	1163.7	1184.1	1185.7	1122.4	1076.9	1051.3	1015.9	990.1	971.4	985.1	981.4	1057.7	1161.8	1182.7	1184.7	1121.4	1075.6	1050.0	1014.6	988.9
Y(t)	1118.0	1135.4	1136.8	1082.2	1042.1	1019.1	987.2	963.6	946.5	959.0	955.7	1024.9	1116.4	1134.2	1135.9	1081.4	1040.9	1018.0	986.0	962.5
Sw(t)	1021.1	1032.8	1017.6	1001.3	993.4	967.4	948.0	911.4	881.3	872.0	865.7	935.8	1019.4	1031.2	1016.4	1000.1	992.1	966.1	946.7	910.1
Ro(t)	37.6	40.1	40.3	33.1	28.7	26.5	23.7	21.8	20.5	21.4	21.2	27.0	37.4	39.9	40.1	33.0	28.6	26.4	23.6	21.7
Rg(t)	8.1	8.6	8.6	7.1	6.2	5.7	5.1	4.7	4.4	4.6	4.5	5.8	8.0	8.6	8.6	7.1	6.1	5.7	5.1	4.7
Sg(t)	4698.8	4700.3	4701.9	4701.9	4701.0	4699.6	4697.6	4695.2	4692.6	4690.1	4687.6	4686.4	4687.3	4688.8	4690.4	4690.4	4689.5	4688.1	4686.1	4683.7
Qg(t)	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.0
Q(t)	44.7	47.1	47.3	40.2	35.8	33.5	30.7	28.9	27.6	28.5	28.2	34.1	44.4	46.9	47.2	40.0	35.6	33.4	30.6	28.8
E(t)	96.8	102.6	119.1	80.9	48.7	51.7	39.2	52.3	65.2	87.0	89.9	89.1	97.0	103.1	119.6	81.2	48.8	51.9	39.3	52.4

Appendix D (Continued)

Table D9. (Continued)

	2026				2027												2028			
	681	682	683	684	685	686	687	688	689	690	691	692	693	694	695	696	697	698	699	700
	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A
P(t)	59.9	103.1	107.1	192.6	228.0	163.7	154.2	105.3	75.4	57.9	48.5	42.2	59.8	102.5	104.8	193.2	230.0	164.0	154.9	105.6
PE(t)	119.7	159.8	166.1	151.9	151.9	159.6	186.1	130.7	80.4	87.4	67.9	93.7	120.5	161.3	167.5	152.5	152.4	160.5	186.9	131.4
W(t)	970.0	982.8	976.4	1053.4	1160.0	1181.3	1183.8	1120.5	1074.4	1048.8	1013.3	987.6	968.6	980.5	971.5	1049.2	1158.2	1180.0	1182.8	1119.5
Y(t)	945.2	956.9	951.1	1021.1	1114.8	1133.1	1135.1	1080.5	1039.8	1016.9	984.8	961.4	943.9	954.8	946.5	1017.2	1113.3	1132.0	1134.4	1079.7
Sw(t)	879.6	869.4	860.8	932.0	1017.7	1029.5	1015.1	998.9	990.8	964.9	945.5	908.8	878.0	866.7	855.9	928.2	1016.0	1027.9	1013.9	997.7
Ro(t)	20.4	21.3	20.9	26.6	37.2	39.7	40.0	32.9	28.5	26.3	23.5	21.6	20.3	21.1	20.5	26.3	37.0	39.6	39.9	32.8
Rg(t)	4.4	4.6	4.5	5.7	8.0	8.5	8.6	7.1	6.1	5.6	5.0	4.6	4.4	4.5	4.4	5.6	7.9	8.5	8.6	7.0
Sg(t)	4681.1	4678.6	4676.0	4674.7	4675.7	4677.1	4678.7	4678.7	4677.8	4676.4	4674.4	4672.0	4669.3	4666.9	4664.2	4662.9	4663.8	4665.3	4666.8	4666.8
Qg(t)	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
Q(t)	27.5	28.3	27.9	33.7	44.2	46.8	47.1	39.9	35.5	33.3	30.5	28.7	27.4	28.2	27.5	33.3	44.0	46.6	46.9	39.8
E(t)	65.6	87.6	90.3	89.0	97.2	103.6	120.0	81.6	49.0	52.0	39.4	52.6	65.9	88.2	90.6	89.0	97.3	104.0	120.4	81.9

	2028								2029											
	701	702	703	704	705	706	707	708	709	710	711	712	713	714	715	716	717	718	719	720
	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
P(t)	75.4	58.0	48.5	42.2	59.7	101.8	102.6	193.9	232.0	164.4	155.6	105.9	75.3	58.0	48.5	42.2	59.6	101.2	100.4	194.5
PE(t)	80.7	87.7	68.2	94.1	121.3	162.9	169.0	153.0	152.9	161.5	187.8	132.1	81.1	88.1	68.5	94.5	122.1	164.5	170.6	153.5
W(t)	1073.1	1047.5	1012.1	986.4	967.2	978.2	966.5	1044.9	1156.5	1178.7	1181.9	1118.5	1071.9	1046.2	1010.8	985.1	965.8	975.9	961.6	1040.7
Y(t)	1038.7	1015.7	983.7	960.2	942.6	952.7	942.0	1013.4	1111.8	1130.8	1133.6	1078.8	1037.6	1014.6	982.5	959.1	941.3	950.6	937.5	1009.6
Sw(t)	989.5	963.6	944.2	907.5	876.4	863.9	851.1	924.5	1014.3	1026.3	1012.7	996.5	988.2	962.3	942.9	906.2	874.7	861.2	846.2	920.7
Ro(t)	28.4	26.2	23.4	21.5	20.2	21.0	20.2	25.9	36.8	39.4	39.8	32.7	28.2	26.0	23.3	21.4	20.2	20.8	19.9	25.6
Rg(t)	6.1	5.6	5.0	4.6	4.3	4.5	4.3	5.6	7.9	8.5	8.5	7.0	6.1	5.6	5.0	4.6	4.3	4.5	4.3	5.5
Sg(t)	4665.9	4664.5	4662.5	4660.1	4657.4	4654.9	4652.3	4650.8	4651.7	4653.2	4654.7	4654.7	4653.8	4652.4	4650.4	4648.0	4645.3	4642.8	4640.1	4638.6
Qg(t)	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
Q(t)	35.4	33.2	30.4	28.5	27.3	28.0	27.2	32.9	43.8	46.4	46.8	39.7	35.2	33.0	30.3	28.4	27.1	27.8	26.9	32.6
E(t)	49.2	52.1	39.5	52.7	66.2	88.8	90.9	89.0	97.5	104.5	120.9	82.3	49.3	52.3	39.6	52.9	66.6	89.4	91.3	88.9

Appendix D (Continued)

Table D9. (Continued)

	2030 721 J	722 F	723 M	724 A	725 M	726 J	727 J	728 A	729 S	730 O	731 N	732 D	2031 733 J	734 F	735 M	736 A	737 M	738 J	739 J	740 A
P(t)	234.1	164.8	156.3	106.1	75.3	58.0	48.5	42.2	59.5	100.5	98.3	195.1	236.1	165.2	157.0	106.4	75.2	58.0	48.5	42.3
PE(t)	153.4	162.5	188.7	132.8	81.5	88.4	68.7	94.9	122.9	166.1	172.1	154.1	153.9	163.5	189.6	133.5	81.9	88.7	69.0	95.3
W(t)	1154.8	1157.5	1145.4	1070.9	1016.4	984.5	944.7	915.5	894.2	903.2	887.6	968.8	1084.5	1104.8	1106.4	1042.0	993.2	965.1	928.3	901.3
Y(t)	1090.0	1092.2	1082.4	1020.5	973.7	945.9	910.6	884.4	865.2	873.4	859.3	932.0	1032.0	1048.9	1050.3	995.9	953.5	928.7	895.9	871.6
Sw(t)	992.7	989.2	964.8	941.1	926.5	896.2	873.2	834.7	802.7	789.3	773.7	848.4	939.6	949.4	935.7	918.0	907.0	879.8	859.0	822.4
Ro(t)	56.6	57.0	55.0	44.0	37.3	33.8	29.8	27.1	25.3	26.1	24.8	32.1	45.9	48.7	49.0	40.3	34.7	31.8	28.3	25.9
Rg(t)	8.2	8.3	8.0	6.4	5.4	4.9	4.3	3.9	3.7	3.8	3.6	4.7	6.7	7.1	7.1	5.9	5.0	4.6	4.1	3.8
Sg(t)	4639.4	4640.2	4640.7	4639.7	4637.6	4635.1	4632.0	4628.5	4624.7	4621.1	4617.3	4614.5	4613.8	4613.5	4613.2	4611.6	4609.3	4606.5	4603.2	4599.6
Qg(t)	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4
Q(t)	64.0	64.5	62.5	51.5	44.7	41.2	37.2	34.5	32.7	33.5	32.2	39.5	53.3	56.2	56.4	47.7	42.1	39.1	35.6	33.3
E(t)	97.3	103.0	117.6	79.4	47.2	49.6	37.4	49.7	62.5	84.1	85.6	83.6	92.4	99.5	114.6	77.9	46.4	48.9	36.9	49.2
	2031 741 S	742 O	743 N	744 D	2032 745 J	746 F	747 M	748 A	749 M	750 J	751 J	752 A	753 S	754 O	755 N	756 D	2033 757 J	758 F	759 M	760 A
P(t)	59.4	99.9	96.2	195.7	238.2	165.6	157.6	106.7	75.1	58.0	48.5	42.3	59.3	99.2	94.2	196.4	240.3	165.9	158.3	106.9
PE(t)	123.8	167.7	173.7	154.7	154.4	164.5	190.5	134.3	82.3	89.1	69.3	95.8	124.6	169.3	175.3	155.2	154.9	165.5	191.4	135.0
W(t)	881.8	891.7	875.4	958.6	1078.2	1100.0	1102.9	1039.2	990.5	962.6	926.0	899.2	879.7	888.9	870.3	954.3	1076.5	1098.8	1102.1	1038.4
Y(t)	854.0	863.0	848.1	923.0	1026.7	1044.9	1047.4	993.4	951.1	926.5	893.9	869.7	852.1	860.4	843.5	919.2	1025.3	1043.9	1046.7	992.7
Sw(t)	791.9	779.1	762.9	840.0	934.4	945.2	932.5	915.3	904.6	877.5	856.9	820.4	789.7	776.0	758.0	836.2	932.8	943.8	931.4	914.3
Ro(t)	24.3	25.1	23.8	31.1	45.0	48.1	48.5	40.0	34.4	31.5	28.0	25.7	24.1	24.9	23.4	30.7	44.8	47.9	48.4	39.9
Rg(t)	3.5	3.6	3.5	4.5	6.5	7.0	7.0	5.8	5.0	4.6	4.1	3.7	3.5	3.6	3.4	4.5	6.5	6.9	7.0	5.8
Sg(t)	4595.7	4592.0	4588.1	4585.2	4584.4	4584.0	4583.7	4582.1	4579.8	4577.0	4573.7	4570.1	4566.3	4562.6	4558.7	4555.8	4555.0	4554.6	4554.4	4552.8
Qg(t)	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3
Q(t)	31.7	32.5	31.2	38.5	52.4	55.4	55.8	47.3	41.7	38.9	35.4	33.1	31.5	32.2	30.7	38.0	52.1	55.2	55.7	47.2
E(t)	62.1	83.9	85.2	83.1	92.2	99.7	114.8	78.1	46.5	49.0	37.0	49.3	62.3	84.4	85.5	83.0	92.4	100.2	115.3	78.4

Appendix D (Continued)

Table D9. (Continued)

	2033								2034											
	761	762	763	764	765	766	767	768	769	770	771	772	773	774	775	776	777	778	779	780
	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
P(t)	75.1	58.1	48.5	42.3	59.2	98.6	92.2	197.0	242.4	166.3	159.0	107.2	75.0	58.1	48.5	42.3	59.1	97.9	90.3	197.6
PE(t)	82.7	89.4	69.6	96.2	125.5	171.0	176.9	155.8	155.5	166.5	192.3	135.8	83.1	89.8	69.9	96.6	126.4	172.7	178.6	156.4
W(t)	989.4	961.5	924.9	898.1	878.4	886.8	865.7	950.5	1075.3	1097.9	1101.5	1037.7	988.3	960.4	923.8	897.1	877.2	884.7	861.3	946.8
Y(t)	950.1	925.5	892.9	868.7	850.9	858.5	839.3	915.8	1024.2	1043.2	1046.3	992.1	949.2	924.6	891.9	867.8	849.8	856.6	835.3	912.4
Sw(t)	903.4	876.4	855.8	819.3	788.2	773.5	753.5	832.8	931.6	942.5	930.5	913.3	902.3	875.3	854.7	818.2	786.8	771.0	749.1	829.5
Ro(t)	34.3	31.4	27.9	25.6	24.0	24.7	23.0	30.3	44.6	47.8	48.3	39.8	34.2	31.3	27.8	25.5	23.9	24.5	22.7	30.0
Rg(t)	5.0	4.6	4.1	3.7	3.5	3.6	3.3	4.4	6.5	6.9	7.0	5.8	5.0	4.5	4.0	3.7	3.5	3.6	3.3	4.3
Sg(t)	4550.5	4547.8	4544.5	4541.0	4537.2	4533.5	4529.5	4526.7	4525.9	4525.6	4525.3	4523.8	4521.5	4518.8	4515.6	4512.1	4508.3	4504.6	4500.7	4497.8
Qg(t)	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.2	7.2	7.2	7.2	7.2	7.2
Q(t)	41.6	38.7	35.2	32.9	31.3	32.0	30.3	37.6	51.9	55.0	55.5	47.0	41.4	38.5	35.1	32.8	31.2	31.8	29.9	37.2
E(t)	46.7	49.1	37.1	49.5	62.7	85.0	85.8	83.0	92.6	100.7	115.8	78.8	46.9	49.3	37.2	49.7	63.0	85.6	86.2	83.0

	2035												2036							
	781	782	783	784	785	786	787	788	789	790	791	792	793	794	795	796	797	798	799	800
	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A
P(t)	244.6	166.7	159.7	107.5	75.0	58.1	48.5	42.4	58.9	97.3	88.4	198.3	246.7	167.1	160.4	107.7	74.9	58.1	48.5	42.4
PE(t)	156.0	167.5	193.3	136.5	83.5	90.2	70.2	97.1	127.2	174.5	180.2	156.9	156.5	168.6	194.2	137.3	83.9	90.5	70.4	97.5
W(t)	1074.1	1097.0	1101.0	1037.0	987.3	959.4	922.7	896.0	876.0	882.6	856.9	943.0	1072.9	1096.2	1100.5	1036.4	986.3	958.4	921.7	895.0
Y(t)	1023.2	1042.5	1045.8	991.6	948.4	923.7	891.0	866.9	848.7	854.7	831.2	909.1	1022.2	1041.8	1045.4	991.0	947.5	922.8	890.0	865.9
Sw(t)	930.3	941.3	929.6	912.4	901.3	874.3	853.7	817.1	785.3	768.5	744.7	826.2	929.1	940.0	928.7	911.4	900.2	873.2	852.6	815.9
Ro(t)	44.4	47.6	48.2	39.7	34.1	31.2	27.8	25.5	23.8	24.4	22.4	29.6	44.3	47.5	48.1	39.6	33.9	31.1	27.7	25.4
Rg(t)	6.4	6.9	7.0	5.8	4.9	4.5	4.0	3.7	3.5	3.5	3.2	4.3	6.4	6.9	7.0	5.7	4.9	4.5	4.0	3.7
Sg(t)	4497.1	4496.8	4496.5	4495.1	4492.8	4490.1	4487.0	4483.5	4479.7	4476.1	4472.2	4469.3	4468.5	4468.3	4468.1	4466.7	4464.4	4461.8	4458.6	4455.2
Qg(t)	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.1
Q(t)	51.7	54.8	55.4	46.9	41.3	38.4	35.0	32.7	31.0	31.5	29.6	36.8	51.5	54.7	55.3	46.8	41.1	38.3	34.8	32.5
E(t)	92.8	101.2	116.2	79.2	47.1	49.4	37.3	49.8	63.3	86.3	86.5	82.9	93.0	101.8	116.7	79.6	47.3	49.5	37.4	50.0

Appendix D (Continued)

Table D9. (Continued)

	2036 801 S	802 O	803 N	804 D	2037 805 J	806 F	807 M	808 A	809 M	810 J	811 J	812 A	813 S	814 O	815 N	816 D	2038 817 J	818 F	819 M	820 A
P(t)	58.8	96.7	86.5	198.9	248.9	167.5	161.1	108.0	74.8	58.2	48.5	42.4	58.7	96.0	84.7	199.6	251.1	167.8	161.9	108.3
PE(t)	128.1	176.3	182.0	157.5	157.1	169.6	195.2	138.0	84.3	90.9	70.7	98.0	129.0	178.1	183.7	158.1	157.6	170.7	196.1	138.8
W(t)	874.8	880.6	852.5	939.3	1071.8	1095.4	1100.0	1035.7	985.3	957.3	920.6	893.9	873.5	878.5	848.1	935.5	1070.6	1094.6	1099.5	1035.1
Y(t)	847.6	852.8	827.2	905.8	1021.2	1041.1	1045.0	990.4	946.6	921.8	889.0	865.0	846.5	850.9	823.2	902.4	1020.3	1040.5	1044.5	989.9
Sw(t)	783.9	766.0	740.4	822.8	928.0	938.8	927.7	910.5	899.2	872.1	851.5	814.8	782.4	763.4	736.0	819.5	926.8	937.6	926.8	909.6
Ro(t)	23.7	24.2	22.0	29.3	44.1	47.4	48.1	39.6	33.8	31.0	27.6	25.3	23.6	24.0	21.7	28.9	44.0	47.3	48.0	39.5
Rg(t)	3.4	3.5	3.2	4.2	6.4	6.9	7.0	5.7	4.9	4.5	4.0	3.7	3.4	3.5	3.2	4.2	6.4	6.9	7.0	5.7
Sg(t)	4451.5	4447.8	4443.9	4441.0	4440.3	4440.1	4439.9	4438.5	4436.3	4433.7	4430.6	4427.1	4423.5	4419.9	4415.9	4413.1	4412.4	4412.1	4412.0	4410.7
Qg(t)	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1
Q(t)	30.9	31.3	29.2	36.4	51.3	54.5	55.2	46.7	41.0	38.1	34.7	32.4	30.7	31.1	28.8	36.0	51.1	54.4	55.1	46.5
E(t)	63.7	86.9	86.9	82.9	93.3	102.3	117.2	79.9	47.4	49.7	37.5	50.2	64.0	87.5	87.2	82.9	93.5	102.9	117.7	80.3

	2038 821 M	822 J	823 J	824 A	825 S	826 O	827 N	828 D	2039 829 J	830 F	831 M	832 A	833 M	834 J	835 J	836 A	837 S	838 O	839 N	840 D
P(t)	74.8	58.2	48.5	42.4	58.6	95.4	82.9	200.2	272.7	168.7	166.5	109.4	74.6	58.2	48.5	42.6	58.4	94.7	90.3	203.9
PE(t)	84.8	91.3	71.0	98.5	130.0	179.9	185.5	158.7	159.6	171.9	199.7	141.1	86.8	92.2	72.5	100.5	132.9	188.5	191.5	160.9
W(t)	984.3	956.3	919.5	892.9	872.3	876.4	843.7	931.8	1088.9	1108.3	1113.7	1044.7	990.5	960.4	922.4	894.7	872.6	874.5	845.7	934.4
Y(t)	945.7	920.9	888.1	864.0	845.3	849.0	819.2	899.1	1035.7	1051.9	1056.4	998.2	951.1	924.5	890.7	865.7	845.6	847.3	821.0	901.4
Sw(t)	898.1	871.1	850.4	813.7	780.9	760.8	731.6	816.2	939.6	947.3	935.3	915.9	902.1	874.0	852.2	814.2	779.8	755.4	730.5	817.2
Ro(t)	33.7	30.9	27.5	25.2	23.6	23.9	21.4	28.6	46.5	49.3	50.1	40.7	34.4	31.3	27.7	25.3	23.6	23.7	21.6	28.8
Rg(t)	4.9	4.5	4.0	3.7	3.4	3.5	3.1	4.1	6.7	7.1	7.3	5.9	5.0	4.5	4.0	3.7	3.4	3.4	3.1	4.2
Sg(t)	4408.5	4405.9	4402.8	4399.4	4395.8	4392.2	4388.3	4385.4	4385.1	4385.2	4385.4	4384.3	4382.2	4379.7	4376.7	4373.4	4369.8	4366.2	4362.4	4359.6
Qg(t)	7.1	7.1	7.1	7.1	7.1	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
Q(t)	40.8	38.0	34.5	32.3	30.6	30.9	28.5	35.6	53.5	56.3	57.1	47.7	41.4	38.3	34.8	32.4	30.6	30.7	28.6	35.8
E(t)	47.6	49.8	37.6	50.3	64.4	88.2	87.6	82.9	96.0	104.7	121.1	82.3	49.0	50.6	38.5	51.5	65.8	92.0	90.5	84.2

Appendix D (Continued)

Table D9. (Continued)

	2040 841 J	842 F	843 M	844 A	845 M	846 J	847 J	848 A	849 S	850 O	851 N	852 D	2041 853 J	854 F	855 M	856 A	857 M	858 J	859 J	860 A
P(t)	275.1	169.1	167.2	109.7	74.5	58.3	48.5	42.6	58.3	94.1	88.4	204.6	275.3	168.4	167.9	109.8	74.4	58.3	48.5	42.6
PE(t)	160.2	173.0	200.7	141.9	87.2	92.6	72.8	101.0	133.9	190.5	193.4	161.5	161.7	175.3	203.0	143.6	87.9	93.2	73.3	101.7
W(t)	1092.3	1111.0	1115.8	1046.0	991.0	960.5	922.4	894.5	872.1	873.0	841.6	930.9	1089.4	1107.3	1112.4	1042.3	987.0	956.9	919.0	891.4
Y(t)	1038.6	1054.1	1058.1	999.3	951.5	924.7	890.6	865.5	845.1	846.0	817.2	898.3	1036.1	1051.0	1055.3	996.1	948.1	921.5	887.6	862.7
Sw(t)	941.9	948.6	936.3	916.4	902.2	873.9	851.9	813.8	778.9	753.2	726.3	814.1	938.9	944.5	932.4	912.6	898.6	870.6	848.8	810.8
Ro(t)	47.0	49.7	50.4	40.8	34.4	31.3	27.7	25.3	23.5	23.6	21.3	28.5	46.6	49.1	49.9	40.4	34.0	30.9	27.4	25.1
Rg(t)	6.8	7.2	7.3	5.9	5.0	4.5	4.0	3.7	3.4	3.4	3.1	4.1	6.8	7.1	7.2	5.9	4.9	4.5	4.0	3.6
Sg(t)	4359.4	4359.6	4359.9	4358.8	4356.8	4354.4	4351.4	4348.1	4344.6	4341.0	4337.2	4334.3	4334.1	4334.3	4334.6	4333.5	4331.5	4329.0	4326.0	4322.8
Qg(t)	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	6.9	6.9	6.9
Q(t)	54.0	56.7	57.4	47.8	41.4	38.3	34.7	32.3	30.5	30.6	28.2	35.4	53.5	56.1	56.8	47.3	41.0	37.9	34.4	32.0
E(t)	96.6	105.5	121.9	82.8	49.3	50.8	38.7	51.7	66.2	92.7	90.9	84.2	97.3	106.5	122.8	83.5	49.5	50.9	38.8	51.9

	2041 861 S	862 O	863 N	864 D	2042 865 J	866 F	867 M	868 A	869 M	870 J	871 J	872 A	873 S	874 O	875 N	876 D	2043 877 J	878 F	879 M	880 A
P(t)	58.2	92.9	78.3	204.9	275.5	167.8	168.5	110.0	74.4	58.3	48.5	42.5	58.1	91.8	69.4	205.2	275.8	167.2	169.2	110.1
PE(t)	135.3	193.4	196.4	163.2	163.2	177.7	205.3	145.3	88.6	93.7	73.7	102.5	136.8	196.5	199.5	165.0	164.8	180.1	207.7	147.1
W(t)	869.0	868.5	826.6	917.7	1078.0	1097.1	1104.1	1035.0	980.2	950.9	913.7	886.6	864.4	862.8	811.7	904.5	1066.6	1086.8	1095.7	1027.5
Y(t)	842.3	841.9	803.4	886.4	1026.5	1042.5	1048.4	989.8	942.1	916.1	882.8	858.3	838.1	836.7	789.7	874.5	1016.9	1033.9	1041.3	983.4
Sw(t)	775.6	748.2	712.8	802.5	929.3	935.5	925.0	905.9	892.6	865.2	844.0	806.3	771.0	742.2	699.3	790.9	919.7	926.5	917.5	899.1
Ro(t)	23.3	23.3	20.2	27.3	45.0	47.6	48.6	39.5	33.3	30.4	27.0	24.7	22.9	22.8	19.2	26.2	43.5	46.2	47.4	38.6
Rg(t)	3.4	3.4	2.9	4.0	6.5	6.9	7.1	5.7	4.8	4.4	3.9	3.6	3.3	3.3	2.8	3.8	6.3	6.7	6.9	5.6
Sg(t)	4319.2	4315.6	4311.7	4308.7	4308.3	4308.3	4308.5	4307.3	4305.2	4302.7	4299.7	4296.4	4292.8	4289.3	4285.2	4282.1	4281.5	4281.4	4281.4	4280.1
Qg(t)	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9
Q(t)	30.2	30.2	27.1	34.2	51.9	54.6	55.6	46.4	40.2	37.3	33.9	31.6	29.8	29.7	26.1	33.0	50.3	53.1	54.3	45.4
E(t)	66.7	93.7	90.7	83.9	97.2	107.0	123.4	83.9	49.6	50.9	38.8	52.0	67.1	94.4	90.4	83.7	97.2	107.5	123.9	84.3

Appendix D (Continued)

Table D9. (Continued)

	2043 881 M	882 J	883 J	884 A	885 S	886 O	887 N	888 D	2044 889 J	890 F	891 M	892 A	893 M	894 J	895 J	896 A	897 S	898 O	899 N	900 D
P(t)	74.3	58.4	48.5	42.5	58.0	90.7	61.6	205.6	276.0	166.5	169.9	110.2	74.2	58.4	48.5	42.5	57.9	89.6	54.6	205.9
PE(t)	89.3	94.3	74.2	103.3	138.4	199.6	202.6	166.8	166.4	182.5	210.2	148.9	90.1	94.8	74.7	104.1	139.9	202.8	205.9	168.6
W(t)	973.3	944.8	908.3	881.6	859.7	857.0	797.7	892.1	1055.8	1077.0	1087.5	1020.3	966.5	938.7	902.9	876.7	855.0	851.3	784.6	880.3
Y(t)	936.0	910.7	877.9	853.8	833.8	831.4	776.8	863.3	1007.7	1025.6	1034.5	977.1	930.0	905.2	873.1	849.3	829.5	826.1	764.6	852.6
Sw(t)	886.4	859.8	839.1	801.7	766.4	736.1	686.5	779.8	910.5	917.6	910.1	892.3	880.3	854.4	834.2	797.1	761.7	730.0	674.4	769.3
Ro(t)	32.6	29.8	26.5	24.3	22.6	22.4	18.3	25.1	42.1	44.8	46.3	37.7	31.9	29.2	26.0	23.9	22.2	22.0	17.5	24.2
Rg(t)	4.7	4.3	3.8	3.5	3.3	3.2	2.7	3.6	6.1	6.5	6.7	5.5	4.6	4.2	3.8	3.5	3.2	3.2	2.5	3.5
Sg(t)	4278.0	4275.4	4272.4	4269.1	4265.5	4261.9	4257.8	4254.6	4253.9	4253.5	4253.4	4252.1	4249.9	4247.3	4244.3	4240.9	4237.4	4233.8	4229.5	4226.2
Qg(t)	6.9	6.9	6.9	6.9	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8
Q(t)	39.5	36.6	33.3	31.1	29.4	29.2	25.1	32.0	48.9	51.7	53.1	44.5	38.7	36.0	32.8	30.7	29.0	28.8	24.3	31.0
E(t)	49.6	50.9	38.8	52.1	67.4	95.3	90.3	83.4	97.2	108.0	124.4	84.8	49.7	50.9	38.9	52.2	67.8	96.1	90.2	83.3

	2045 901 J	902 F	903 M	904 A	905 M	906 J	907 J	908 A	909 S	910 O	911 N	912 D	2046 913 J	914 F	915 M	916 A	917 M	918 J	919 J	920 A
P(t)	276.2	165.9	170.5	110.3	74.1	58.4	48.5	42.5	57.8	88.5	48.4	206.2	276.4	165.3	171.2	110.5	74.1	58.4	48.5	42.5
PE(t)	168.0	185.1	212.7	150.7	90.8	95.4	75.1	104.9	141.5	206.1	209.2	170.5	169.7	187.7	215.3	152.6	91.6	96.0	75.6	105.7
W(t)	1045.5	1067.5	1079.6	1013.1	959.8	932.7	897.5	871.8	850.3	845.5	772.3	869.1	1035.7	1058.3	1071.8	1006.1	953.1	926.7	892.2	866.9
Y(t)	998.9	1017.6	1027.8	970.9	924.0	899.9	868.2	844.9	825.2	820.8	753.1	842.4	990.4	1009.8	1021.3	964.8	918.1	894.5	863.4	840.4
Sw(t)	901.6	909.0	902.8	885.7	874.3	849.0	829.3	792.5	757.0	723.9	662.9	759.3	893.1	900.6	895.7	879.1	868.3	843.7	824.5	788.0
Ro(t)	40.8	43.6	45.2	36.9	31.2	28.7	25.6	23.5	21.9	21.5	16.7	23.3	39.5	42.4	44.1	36.1	30.6	28.1	25.1	23.1
Rg(t)	5.9	6.3	6.6	5.4	4.5	4.2	3.7	3.4	3.2	3.1	2.4	3.4	5.7	6.1	6.4	5.2	4.4	4.1	3.6	3.4
Sg(t)	4225.4	4224.9	4224.7	4223.3	4221.0	4218.4	4215.4	4212.0	4208.4	4204.8	4200.5	4197.1	4196.1	4195.6	4195.2	4193.7	4191.5	4188.8	4185.7	4182.4
Qg(t)	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7
Q(t)	47.5	50.4	52.0	43.7	38.0	35.4	32.3	30.3	28.6	28.3	23.5	30.0	46.3	49.1	50.9	42.8	37.3	34.8	31.9	29.8
E(t)	97.3	108.6	125.0	85.2	49.8	50.8	38.9	52.3	68.2	96.9	90.2	83.2	97.4	109.2	125.6	85.7	49.9	50.8	38.9	52.5

Appendix D (Continued)

Table D9. (Continued)

	2046 921 S	922 O	923 N	924 D	2047 925 J	926 F	927 M	928 A	929 M	930 J	931 J	932 A	933 S	934 O	935 N	936 D	2048 937 J	938 F	939 M	940 A
P(t)	57.7	87.4	42.9	206.6	276.7	164.6	171.9	110.6	74.0	58.5	48.5	42.4	57.6	86.3	38.0	206.9	276.9	164.0	172.6	110.7
PE(t)	143.1	209.5	212.7	172.4	171.4	190.4	217.9	154.6	92.4	96.6	76.1	106.6	144.8	213.0	216.2	174.4	173.2	193.1	220.6	156.6
W(t)	845.6	839.7	760.6	858.5	1026.3	1049.5	1064.3	999.2	946.5	920.8	886.8	862.0	841.0	833.9	749.6	848.4	1017.3	1040.9	1056.9	992.4
Y(t)	821.0	815.5	742.2	832.8	982.3	1002.3	1014.9	958.8	912.2	889.2	858.5	836.0	816.7	810.2	731.9	823.5	974.5	994.9	1008.6	952.8
Sw(t)	752.4	717.7	652.0	749.7	884.8	892.4	888.6	872.5	862.3	838.3	819.6	783.4	747.7	711.5	641.5	740.4	876.9	884.4	881.7	866.0
Ro(t)	21.6	21.1	16.1	22.5	38.4	41.2	43.2	35.3	29.9	27.6	24.7	22.8	21.2	20.7	15.4	21.7	37.4	40.2	42.2	34.6
Rg(t)	3.1	3.1	2.3	3.3	5.6	6.0	6.3	5.1	4.3	4.0	3.6	3.3	3.1	3.0	2.2	3.2	5.4	5.8	6.1	5.0
Sg(t)	4178.8	4175.2	4170.8	4167.4	4166.3	4165.6	4165.2	4163.6	4161.3	4158.6	4155.5	4152.2	4148.6	4144.9	4140.5	4137.0	4135.8	4135.0	4134.5	4132.9
Qg(t)	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.6	6.6	6.6	6.6	6.6	6.6
Q(t)	28.3	27.8	22.8	29.2	45.1	47.9	49.8	42.0	36.6	34.3	31.4	29.4	27.9	27.4	22.1	28.4	44.0	46.8	48.8	41.2
E(t)	68.6	97.8	90.3	83.1	97.5	109.8	126.3	86.2	49.9	50.8	38.9	52.6	69.0	98.7	90.4	83.0	97.6	110.5	126.9	86.7

	2048 941 M	942 J	943 J	944 A	945 S	946 O	947 N	948 D	2049 949 J	950 F	951 M	952 A	953 M	954 J	955 J	956 A	957 S	958 O	959 N	960 D
P(t)	73.9	58.5	48.5	42.4	57.5	85.2	33.7	207.2	277.1	163.4	173.3	110.8	73.8	58.5	48.5	42.4	57.4	84.2	29.9	207.5
PE(t)	93.2	97.2	76.6	107.4	146.5	216.6	219.9	176.4	174.9	196.0	223.4	158.6	94.0	97.8	77.1	108.3	148.3	220.4	223.7	178.4
W(t)	940.0	914.8	881.5	857.1	836.3	828.2	739.0	838.6	1008.6	1032.5	1049.7	985.6	933.4	908.9	876.2	852.2	831.6	822.4	728.9	829.2
Y(t)	906.4	883.8	853.7	831.5	812.4	804.9	722.0	814.5	966.9	987.6	1002.4	946.8	900.5	878.5	848.9	827.0	808.0	799.5	712.5	805.9
Sw(t)	856.3	833.0	814.7	778.8	742.9	705.3	631.4	731.5	869.1	876.4	874.8	859.6	850.4	827.7	809.9	774.2	738.2	699.0	621.7	722.8
Ro(t)	29.3	27.1	24.3	22.4	20.9	20.3	14.9	21.0	36.4	39.2	41.3	33.9	28.7	26.5	23.9	22.0	20.6	19.9	14.3	20.4
Rg(t)	4.3	3.9	3.5	3.2	3.0	2.9	2.2	3.1	5.3	5.7	6.0	4.9	4.2	3.9	3.5	3.2	3.0	2.9	2.1	3.0
Sg(t)	4130.5	4127.8	4124.7	4121.4	4117.8	4114.1	4109.7	4106.2	4104.8	4103.9	4103.3	4101.7	4099.3	4096.5	4093.4	4090.1	4086.5	4082.8	4078.4	4074.8
Qg(t)	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.5	6.5
Q(t)	36.0	33.7	30.9	29.0	27.5	26.9	21.5	27.6	43.0	45.7	47.9	40.5	35.3	33.1	30.4	28.6	27.1	26.5	20.9	26.9
E(t)	50.0	50.8	39.0	52.7	69.4	99.6	90.6	83.0	97.8	111.2	127.6	87.3	50.1	50.9	39.0	52.8	69.8	100.5	90.8	83.1

Appendix D (Continued)

Table D9. (Continued)

	2050 961 J	962 F	963 M	964 A	965 M	966 J	967 J	968 A	969 S	970 O	971 N	972 D
P(t)	277.3	162.8	173.9	111.0	73.8	58.6	48.5	42.4	57.3	83.1	26.5	207.9
PE(t)	176.8	198.9	226.2	160.7	94.8	98.4	77.7	109.2	150.1	224.2	227.5	180.6
W(t)	1000.1	1024.3	1042.5	978.9	926.9	903.0	870.8	847.3	826.8	816.5	719.2	820.1
Y(t)	959.5	980.6	996.3	940.9	894.7	873.2	844.0	822.5	803.7	794.2	703.4	797.5
Sw(t)	861.5	868.6	867.9	853.1	844.4	822.3	805.0	769.5	733.4	692.7	612.3	714.4
Ro(t)	35.4	38.2	40.4	33.2	28.1	26.0	23.4	21.7	20.2	19.5	13.8	19.8
Rg(t)	5.1	5.5	5.9	4.8	4.1	3.8	3.4	3.1	2.9	2.8	2.0	2.9
Sg(t)	4073.4	4072.4	4071.7	4070.0	4067.6	4064.8	4061.7	4058.3	4054.8	4051.1	4046.6	4043.0
Qg(t)	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5
Q(t)	42.0	44.7	46.9	39.7	34.7	32.6	30.0	28.2	26.7	26.0	20.3	26.3
E(t)	98.0	112.0	128.4	87.8	50.2	50.9	39.0	53.0	70.3	101.5	91.1	83.1

Appendix D (Continued)

Table D10. Water balance output values – coordinated growth and A2 scenarios (2010-2050) .

	2010												2011							
	481	482	483	484	485	486	487	488	489	490	491	492	493	494	495	496	497	498	499	500
	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A
P(t)	292.8	199.5	119.7	100.3	83.1	7.1	55.2	46.8	74.6	113.4	154.9	188.8	198.1	157.8	143.8	101.2	76.4	57.6	48.5	41.8
PE(t)	144.0	145.2	172.7	120.1	74.6	82.2	63.8	87.3	108.4	138.6	145.4	144.0	144.4	145.9	173.4	120.7	74.9	82.5	64.0	87.6
W(t)	1395.0	1432.9	1380.1	1301.9	1260.7	1182.1	1157.3	1139.0	1135.5	1158.2	1200.5	1265.9	1330.2	1323.3	1303.0	1226.7	1178.0	1149.1	1110.6	1082.3
Y(t)	1343.1	1373.4	1330.8	1264.3	1228.1	1157.0	1134.2	1117.2	1114.0	1135.0	1173.8	1232.7	1270.4	1264.8	1248.3	1183.9	1141.4	1115.7	1081.1	1055.4
Sw(t)	1233.4	1260.4	1201.6	1177.6	1175.0	1102.1	1092.2	1061.0	1044.8	1045.6	1077.1	1132.1	1165.5	1159.3	1125.6	1101.6	1091.5	1062.1	1040.6	1001.6
Ro(t)	40.2	46.0	38.1	29.0	25.2	19.4	17.9	16.8	16.7	17.9	20.6	25.7	48.0	47.0	44.0	34.4	29.4	26.8	23.7	21.7
Rg(t)	11.8	13.5	11.2	8.5	7.4	5.7	5.2	4.9	4.9	5.3	6.0	7.5	11.8	11.5	10.8	8.4	7.2	6.6	5.8	5.3
Sg(t)	4806.6	4813.3	4817.8	4819.5	4820.1	4819.0	4817.5	4815.7	4813.8	4812.3	4811.6	4812.4	4815.0	4817.3	4818.9	4818.1	4816.1	4813.5	4810.2	4806.3
Qg(t)	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2
Q(t)	46.9	52.8	44.9	35.8	32.0	26.2	24.7	23.6	23.4	24.7	27.4	32.4	57.2	56.1	53.2	43.6	38.6	36.0	32.9	30.8
E(t)	109.7	113.0	129.2	86.7	53.0	54.9	42.0	56.2	69.2	89.4	96.7	100.6	104.9	105.5	122.7	82.3	49.9	53.6	40.5	53.8
	2011				2012												2013			
	501	502	503	504	505	506	507	508	509	510	511	512	513	514	515	516	517	518	519	520
	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A
P(t)	61.6	113.6	147.4	183.5	199.8	158.2	144.4	101.4	76.3	57.6	48.5	41.8	61.5	112.9	144.3	184.1	201.6	158.5	145.0	101.7
PE(t)	109.0	139.8	146.5	144.4	144.8	146.7	174.1	121.3	75.2	82.8	64.2	88.0	109.7	141.0	147.7	144.9	145.3	147.5	174.8	121.9
W(t)	1063.2	1086.1	1121.5	1183.1	1251.0	1263.1	1257.5	1192.2	1149.7	1124.9	1089.7	1063.9	1046.9	1071.0	1104.9	1169.2	1241.3	1255.6	1251.8	1187.6
Y(t)	1037.9	1058.8	1090.9	1145.9	1204.8	1215.0	1210.3	1153.9	1116.2	1094.0	1062.1	1038.5	1022.9	1045.0	1075.9	1133.6	1196.5	1208.6	1205.4	1149.9
Sw(t)	972.5	974.1	999.6	1051.2	1105.0	1113.1	1090.8	1073.3	1067.2	1041.2	1022.2	985.4	958.0	960.6	985.1	1039.7	1097.1	1106.8	1085.9	1069.2
Ro(t)	20.4	21.9	24.5	29.9	37.2	38.7	38.0	30.8	26.9	24.8	22.2	20.4	19.3	20.9	23.3	28.6	36.0	37.7	37.3	30.3
Rg(t)	5.0	5.4	6.0	7.3	9.1	9.5	9.3	7.5	6.6	6.1	5.4	5.0	4.7	5.1	5.7	7.0	8.8	9.2	9.1	7.4
Sg(t)	4802.2	4798.4	4795.3	4793.5	4793.4	4793.8	4793.9	4792.3	4789.8	4786.7	4783.1	4779.0	4774.6	4770.6	4767.2	4765.2	4764.9	4765.1	4765.1	4763.5
Qg(t)	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1
Q(t)	29.5	31.1	33.7	39.0	46.3	47.8	47.1	39.9	36.0	33.9	31.3	29.5	28.4	30.0	32.4	37.7	45.1	46.8	46.3	39.4
E(t)	65.4	84.8	91.4	94.6	99.8	101.9	119.5	80.6	49.0	52.7	40.0	53.1	64.8	84.3	90.8	93.9	99.4	101.9	119.5	80.7

Appendix D (Continued)

Table D10. (Continued)

	2013								2014											
	521	522	523	524	525	526	527	528	529	530	531	532	533	534	535	536	537	538	539	540
	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
P(t)	76.3	57.6	48.5	41.8	61.4	112.2	141.2	184.7	203.4	158.9	145.7	101.9	76.2	57.7	48.5	41.8	61.3	111.5	138.3	185.3
PE(t)	75.5	83.1	64.5	88.3	110.4	142.2	148.9	145.4	145.7	148.3	175.6	122.4	75.9	83.3	64.7	88.7	111.0	143.4	150.1	145.8
W(t)	1145.5	1121.1	1086.3	1060.8	1043.9	1067.2	1098.0	1163.4	1238.1	1253.1	1250.0	1186.0	1143.7	1119.4	1084.7	1059.3	1042.2	1064.7	1092.2	1158.5
Y(t)	1112.5	1090.6	1059.0	1035.7	1020.1	1041.6	1069.7	1128.5	1193.7	1206.5	1203.9	1148.5	1110.9	1089.0	1057.5	1034.3	1018.5	1039.2	1064.4	1124.1
Sw(t)	1063.5	1037.8	1019.0	982.5	955.0	956.8	978.7	1034.7	1094.2	1104.3	1084.1	1067.5	1061.7	1036.2	1017.5	980.9	953.2	953.9	973.2	1030.4
Ro(t)	26.5	24.5	21.9	20.2	19.1	20.6	22.8	28.1	35.7	37.4	37.0	30.2	26.4	24.4	21.8	20.1	19.0	20.5	22.3	27.6
Rg(t)	6.5	6.0	5.4	4.9	4.7	5.1	5.6	6.9	8.7	9.2	9.1	7.4	6.5	6.0	5.3	4.9	4.7	5.0	5.5	6.8
Sg(t)	4760.9	4757.8	4754.2	4750.1	4745.7	4741.7	4738.3	4736.1	4735.8	4736.0	4736.0	4734.4	4731.8	4728.8	4725.1	4721.1	4716.7	4712.8	4709.3	4707.1
Qg(t)	9.1	9.1	9.1	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0
Q(t)	35.6	33.6	31.0	29.3	28.2	29.7	31.8	37.1	44.7	46.4	46.1	39.2	35.4	33.4	30.8	29.1	28.0	29.4	31.3	36.6
E(t)	49.0	52.8	40.0	53.2	65.0	84.8	91.0	93.8	99.4	102.2	119.8	80.9	49.2	52.9	40.1	53.3	65.3	85.3	91.2	93.7

	2015												2016							
	541	542	543	544	545	546	547	548	549	550	551	552	553	554	555	556	557	558	559	560
	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A
P(t)	205.2	159.3	146.3	102.2	76.2	57.7	48.5	41.9	61.2	110.7	135.3	185.9	207.0	159.6	146.9	102.5	76.1	57.7	48.5	41.9
PE(t)	146.2	149.1	176.4	123.0	76.2	83.6	64.9	89.0	111.7	144.7	151.3	146.3	146.6	149.9	177.1	123.6	76.5	83.9	65.2	89.4
W(t)	1235.5	1251.2	1248.6	1184.7	1142.2	1117.9	1083.2	1057.9	1040.7	1062.3	1086.5	1153.6	1233.1	1249.4	1247.3	1183.5	1140.8	1116.5	1081.8	1056.5
Y(t)	1191.5	1204.9	1202.7	1147.3	1109.6	1087.7	1056.2	1033.0	1017.1	1037.0	1059.2	1119.8	1189.4	1203.3	1201.6	1146.2	1108.3	1086.4	1054.9	1031.7
Sw(t)	1092.0	1102.3	1082.5	1066.1	1060.3	1034.8	1016.0	979.5	951.5	951.2	967.8	1026.1	1089.7	1100.3	1081.0	1064.7	1058.8	1033.3	1014.7	978.1
Ro(t)	35.4	37.2	36.9	30.0	26.2	24.3	21.7	20.0	18.9	20.3	21.9	27.2	35.1	37.0	36.7	29.9	26.1	24.2	21.6	19.9
Rg(t)	8.7	9.1	9.0	7.4	6.4	5.9	5.3	4.9	4.6	5.0	5.4	6.7	8.6	9.1	9.0	7.3	6.4	5.9	5.3	4.9
Sg(t)	4706.8	4706.9	4707.0	4705.4	4702.8	4699.8	4696.2	4692.2	4687.9	4683.9	4680.4	4678.1	4677.8	4678.0	4678.0	4676.5	4674.0	4671.0	4667.4	4663.4
Qg(t)	9.0	9.0	9.0	9.0	9.0	9.0	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9
Q(t)	44.3	46.2	45.8	39.0	35.2	33.2	30.7	29.0	27.9	29.2	30.9	36.1	44.0	45.9	45.6	38.8	35.0	33.0	30.5	28.8
E(t)	99.6	102.6	120.2	81.2	49.3	53.0	40.2	53.5	65.6	85.8	91.5	93.7	99.7	103.0	120.5	81.5	49.5	53.1	40.2	53.6

Appendix D (Continued)

Table D10. (Continued)

	2016				2017												2018			
	561	562	563	564	565	566	567	568	569	570	571	572	573	574	575	576	577	578	579	580
	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A
P(t)	61.1	110.0	132.5	186.5	208.8	160.0	147.6	102.7	76.0	57.7	48.5	41.9	61.0	109.3	129.7	187.1	210.6	160.3	148.2	103.0
PE(t)	112.4	145.9	152.5	146.8	147.1	150.7	177.9	124.2	76.8	84.2	65.4	89.8	113.1	147.2	153.8	147.3	147.5	151.6	178.7	124.9
W(t)	1039.2	1059.8	1080.9	1148.9	1230.7	1247.5	1246.0	1182.2	1139.3	1115.0	1080.4	1055.2	1037.7	1057.4	1075.4	1144.1	1228.4	1245.8	1244.7	1181.0
Y(t)	1015.7	1034.8	1054.1	1115.5	1187.4	1201.8	1200.4	1145.1	1107.0	1085.1	1053.6	1030.5	1014.3	1032.5	1049.0	1111.3	1185.3	1200.3	1199.3	1144.0
Sw(t)	949.8	948.4	962.4	1021.9	1087.6	1098.4	1079.5	1063.3	1057.3	1031.9	1013.3	976.7	948.1	945.7	957.0	1017.7	1085.4	1096.4	1078.0	1061.9
Ro(t)	18.8	20.1	21.6	26.8	34.8	36.8	36.6	29.8	26.0	24.0	21.5	19.8	18.8	20.0	21.2	26.4	34.6	36.5	36.4	29.7
Rg(t)	4.6	4.9	5.3	6.6	8.5	9.0	9.0	7.3	6.4	5.9	5.3	4.9	4.6	4.9	5.2	6.5	8.5	8.9	8.9	7.3
Sg(t)	4659.1	4655.2	4651.6	4649.3	4649.0	4649.1	4649.2	4647.7	4645.2	4642.2	4638.7	4634.7	4630.5	4626.5	4622.9	4620.6	4620.2	4620.4	4620.5	4619.0
Qg(t)	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8
Q(t)	27.7	29.0	30.4	35.6	43.7	45.6	45.4	38.7	34.8	32.9	30.4	28.7	27.6	28.8	30.0	35.2	43.4	45.3	45.2	38.5
E(t)	65.9	86.3	91.7	93.6	99.8	103.4	120.9	81.9	49.6	53.2	40.3	53.8	66.2	86.9	92.0	93.5	99.9	103.8	121.3	82.2

	2018								2019											
	581	582	583	584	585	586	587	588	589	590	591	592	593	594	595	596	597	598	599	600
	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
P(t)	76.0	57.7	48.5	41.9	60.8	108.6	127.0	187.7	212.5	160.7	148.9	103.2	75.9	57.8	48.5	42.0	60.7	107.9	124.3	188.3
PE(t)	77.2	84.5	65.6	90.1	113.8	148.5	155.1	147.8	148.0	152.4	179.5	125.5	77.5	84.8	65.9	90.5	114.5	149.9	156.4	148.3
W(t)	1137.8	1113.6	1079.0	1053.8	1036.1	1055.0	1069.9	1139.4	1226.0	1244.0	1243.4	1179.7	1136.4	1112.2	1077.5	1052.4	1034.6	1052.6	1064.4	1134.7
Y(t)	1105.6	1083.8	1052.3	1029.2	1012.9	1030.3	1044.0	1107.0	1183.3	1198.8	1198.2	1142.9	1104.3	1082.5	1051.0	1027.9	1011.5	1028.1	1038.9	1102.8
Sw(t)	1055.9	1030.5	1011.9	975.3	946.4	942.9	951.7	1013.5	1083.3	1094.5	1076.5	1060.5	1054.4	1029.0	1010.5	973.9	944.7	940.1	946.4	1009.4
Ro(t)	25.9	23.9	21.4	19.8	18.7	19.8	20.8	26.0	34.3	36.3	36.3	29.6	25.7	23.8	21.3	19.7	18.6	19.7	20.4	25.6
Rg(t)	6.3	5.9	5.2	4.8	4.6	4.9	5.1	6.4	8.4	8.9	8.9	7.2	6.3	5.8	5.2	4.8	4.5	4.8	5.0	6.3
Sg(t)	4616.5	4613.6	4610.1	4606.1	4601.9	4598.0	4594.4	4592.0	4591.6	4591.8	4591.9	4590.4	4588.0	4585.1	4581.6	4577.7	4573.5	4569.6	4565.9	4563.5
Qg(t)	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
Q(t)	34.7	32.7	30.2	28.5	27.4	28.6	29.6	34.7	43.0	45.1	45.0	38.3	34.5	32.6	30.0	28.4	27.3	28.4	29.1	34.3
E(t)	49.8	53.3	40.4	53.9	66.5	87.4	92.3	93.5	100.1	104.3	121.7	82.5	49.9	53.5	40.5	54.1	66.8	88.0	92.6	93.4

Appendix D (Continued)

Table D10. (Continued)

	2020 601 J	602 F	603 M	604 A	605 M	606 J	607 J	608 A	609 S	610 O	611 N	612 D	2021 613 J	614 F	615 M	616 A	617 M	618 J	619 J	620 A
P(t)	214.4	161.1	149.6	103.5	75.9	57.8	48.5	42.0	60.6	107.2	121.7	188.9	216.3	161.4	150.2	103.7	75.8	57.8	48.5	42.0
PE(t)	148.5	153.3	180.2	126.1	77.9	85.2	66.1	90.9	115.2	151.2	157.7	148.8	149.0	154.2	181.1	126.8	78.2	85.5	66.4	91.3
W(t)	1223.7	1242.2	1242.1	1178.5	1134.9	1110.7	1076.1	1051.0	1033.0	1050.1	1059.0	1130.0	1221.5	1240.5	1240.9	1177.3	1133.5	1109.3	1074.7	1049.6
Y(t)	1181.4	1197.3	1197.2	1141.9	1103.0	1081.2	1049.7	1026.6	1010.0	1025.8	1034.0	1098.6	1179.4	1195.8	1196.1	1140.8	1101.7	1079.9	1048.4	1025.4
Sw(t)	1081.2	1092.6	1075.0	1059.1	1052.9	1027.6	1009.0	972.4	942.9	937.3	941.1	1005.2	1079.1	1090.7	1073.6	1057.7	1051.5	1026.2	1007.6	971.0
Ro(t)	34.0	36.1	36.1	29.5	25.6	23.7	21.2	19.6	18.5	19.5	20.1	25.2	33.8	35.9	36.0	29.3	25.5	23.6	21.1	19.5
Rg(t)	8.3	8.8	8.8	7.2	6.3	5.8	5.2	4.8	4.5	4.8	4.9	6.2	8.3	8.8	8.8	7.2	6.2	5.8	5.2	4.8
Sg(t)	4563.2	4563.3	4563.5	4562.0	4559.6	4556.7	4553.2	4549.4	4545.2	4541.4	4537.6	4535.2	4534.8	4535.0	4535.1	4533.7	4531.3	4528.5	4525.0	4521.2
Qg(t)	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6
Q(t)	42.7	44.8	44.8	38.1	34.3	32.4	29.9	28.2	27.1	28.2	28.7	33.9	42.4	44.6	44.6	38.0	34.1	32.2	29.7	28.1
E(t)	100.2	104.7	122.1	82.8	50.1	53.6	40.6	54.2	67.1	88.5	92.9	93.4	100.3	105.1	122.5	83.1	50.2	53.7	40.7	54.4

	2021 621 S	622 O	623 N	624 D	2022 625 J	626 F	627 M	628 A	629 M	630 J	631 J	632 A	633 S	634 O	635 N	636 D	2023 637 J	638 F	639 M	640 A
P(t)	60.5	106.5	119.1	189.5	218.2	161.8	150.9	104.0	75.7	57.8	48.5	42.0	60.4	105.8	116.6	190.1	220.1	162.2	151.5	104.3
PE(t)	115.9	152.6	159.0	149.3	149.4	155.0	181.9	127.4	78.6	85.8	66.6	91.7	116.7	154.0	160.4	149.8	149.9	155.9	182.7	128.0
W(t)	1031.5	1047.7	1053.6	1125.3	1219.3	1238.8	1239.6	1176.1	1132.0	1107.8	1073.2	1048.2	1029.9	1045.3	1048.2	1120.7	1217.1	1237.1	1238.4	1174.9
Y(t)	1008.6	1023.6	1029.0	1094.4	1177.5	1194.3	1195.0	1139.7	1100.4	1078.6	1047.0	1024.1	1007.2	1021.3	1024.1	1090.2	1175.6	1192.9	1194.0	1138.6
Sw(t)	941.2	934.5	935.8	1001.1	1077.0	1088.8	1072.1	1056.3	1050.0	1024.7	1006.2	969.6	939.4	931.6	930.6	997.0	1075.0	1086.9	1070.6	1054.9
Ro(t)	18.4	19.4	19.7	24.8	33.6	35.7	35.8	29.2	25.4	23.5	21.0	19.4	18.3	19.2	19.4	24.5	33.3	35.5	35.7	29.1
Rg(t)	4.5	4.7	4.8	6.1	8.2	8.8	8.8	7.2	6.2	5.8	5.1	4.8	4.5	4.7	4.8	6.0	8.2	8.7	8.7	7.1
Sg(t)	4517.1	4513.2	4509.5	4507.0	4506.6	4506.8	4507.0	4505.5	4503.2	4500.4	4496.9	4493.1	4489.1	4485.2	4481.4	4478.9	4478.5	4478.7	4478.9	4477.5
Qg(t)	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.5	8.5	8.5	8.5	8.5	8.5	8.5
Q(t)	27.0	28.0	28.3	33.4	42.1	44.3	44.4	37.8	34.0	32.1	29.6	28.0	26.8	27.8	27.9	33.0	41.9	44.1	44.2	37.6
E(t)	67.4	89.1	93.2	93.3	100.5	105.6	122.9	83.5	50.4	53.8	40.8	54.5	67.7	89.7	93.5	93.3	100.6	106.0	123.4	83.8

Appendix D (Continued)

Table D10. (Continued)

	2023 641 M	642 J	643 J	644 A	645 S	646 O	647 N	648 D	2024 649 J	650 F	651 M	652 A	653 M	654 J	655 J	656 A	657 S	658 O	659 N	660 D
P(t)	75.7	57.9	48.5	42.1	60.3	105.2	114.1	190.7	222.1	162.6	152.2	104.5	75.6	57.9	48.5	42.1	60.2	104.5	111.7	191.4
PE(t)	78.9	86.1	66.9	92.1	117.4	155.4	161.8	150.3	150.4	156.8	183.5	128.7	79.3	86.4	67.1	92.4	118.2	156.9	163.2	150.9
W(t)	1130.5	1106.4	1071.8	1046.8	1028.4	1042.8	1042.9	1116.1	1214.9	1235.5	1237.2	1173.7	1129.1	1104.9	1070.3	1045.4	1026.8	1040.4	1037.6	1111.5
Y(t)	1099.1	1077.3	1045.7	1022.8	1005.7	1019.1	1019.2	1086.1	1173.7	1191.5	1192.9	1137.6	1097.8	1075.9	1044.4	1021.5	1004.3	1016.8	1014.3	1081.9
Sw(t)	1048.5	1023.3	1004.8	968.1	937.7	928.8	925.4	992.8	1072.9	1085.0	1069.2	1053.5	1047.0	1021.8	1003.4	966.7	935.9	925.9	920.2	988.8
Ro(t)	25.3	23.4	20.9	19.3	18.2	19.1	19.1	24.1	33.1	35.4	35.6	29.0	25.1	23.3	20.8	19.2	18.1	18.9	18.8	23.8
Rg(t)	6.2	5.7	5.1	4.7	4.5	4.7	4.7	5.9	8.1	8.7	8.7	7.1	6.2	5.7	5.1	4.7	4.4	4.6	4.6	5.8
Sg(t)	4475.2	4472.4	4469.0	4465.2	4461.2	4457.4	4453.6	4451.0	4450.6	4450.8	4451.0	4449.6	4447.3	4444.6	4441.2	4437.5	4433.5	4429.7	4425.8	4423.2
Qg(t)	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.4	8.4	8.4	8.4
Q(t)	33.8	31.9	29.4	27.8	26.7	27.6	27.6	32.6	41.6	43.8	44.0	37.5	33.6	31.7	29.3	27.7	26.6	27.4	27.2	32.2
E(t)	50.6	54.0	40.9	54.7	68.1	90.3	93.8	93.2	100.8	106.5	123.8	84.1	50.7	54.1	41.0	54.8	68.4	90.9	94.1	93.2

	2025 661 J	662 F	663 M	664 A	665 M	666 J	667 J	668 A	669 S	670 O	671 N	672 D	2026 673 J	674 F	675 M	676 A	677 M	678 J	679 J	680 A
P(t)	224.0	162.9	152.9	104.8	75.6	57.9	48.5	42.1	60.1	103.8	109.4	192.0	226.0	163.3	153.5	105.1	75.5	57.9	48.5	42.1
PE(t)	150.9	157.7	184.4	129.4	79.6	86.7	67.4	92.8	118.9	158.3	164.6	151.4	151.4	158.7	185.2	130.0	80.0	87.1	67.7	93.3
W(t)	1212.8	1233.8	1236.0	1172.5	1127.6	1103.5	1068.9	1044.0	1025.2	1037.9	1032.4	1107.0	1210.7	1232.2	1234.8	1171.3	1126.2	1102.0	1067.4	1042.6
Y(t)	1171.8	1190.1	1191.9	1136.5	1096.5	1074.6	1043.1	1020.2	1002.8	1014.5	1009.4	1077.8	1170.0	1188.7	1190.9	1135.5	1095.2	1073.3	1041.7	1018.9
Sw(t)	1070.9	1083.1	1067.7	1052.1	1045.6	1020.4	1001.9	965.2	934.1	923.0	915.0	984.7	1068.9	1081.3	1066.2	1050.7	1044.1	1018.9	1000.5	963.7
Ro(t)	32.9	35.2	35.4	28.9	25.0	23.2	20.7	19.1	18.0	18.8	18.4	23.4	32.6	35.0	35.3	28.8	24.9	23.1	20.6	19.1
Rg(t)	8.0	8.6	8.7	7.1	6.1	5.7	5.1	4.7	4.4	4.6	4.5	5.7	8.0	8.6	8.6	7.0	6.1	5.6	5.1	4.7
Sg(t)	4422.8	4423.0	4423.3	4421.9	4419.6	4416.9	4413.6	4409.9	4405.9	4402.1	4398.2	4395.6	4395.2	4395.4	4395.7	4394.4	4392.1	4389.4	4386.1	4382.4
Qg(t)	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.3
Q(t)	41.3	43.6	43.8	37.3	33.4	31.6	29.1	27.5	26.4	27.2	26.8	31.8	41.0	43.4	43.7	37.2	33.3	31.4	29.0	27.4
E(t)	100.9	106.9	124.2	84.5	50.9	54.2	41.1	55.0	68.7	91.5	94.5	93.1	101.1	107.4	124.6	84.8	51.1	54.4	41.2	55.2

Appendix D (Continued)

Table D10. (Continued)

	2026				2027												2028			
	681	682	683	684	685	686	687	688	689	690	691	692	693	694	695	696	697	698	699	700
	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A
P(t)	59.9	103.1	107.1	192.6	228.0	163.7	154.2	105.3	75.4	57.9	48.5	42.2	59.8	102.5	104.8	193.2	230.0	164.0	154.9	105.6
PE(t)	119.7	159.8	166.1	151.9	151.9	159.6	186.1	130.7	80.4	87.4	67.9	93.7	120.5	161.3	167.5	152.5	152.4	160.5	186.9	131.4
W(t)	1023.7	1035.4	1027.2	1102.4	1208.6	1230.6	1233.6	1170.1	1124.7	1100.5	1065.9	1041.2	1022.1	1032.9	1022.0	1097.9	1206.5	1229.1	1232.5	1168.9
Y(t)	1001.3	1012.2	1004.6	1073.7	1168.2	1187.3	1189.9	1134.4	1093.8	1072.0	1040.4	1017.6	999.9	1009.9	999.8	1069.6	1166.4	1185.9	1188.9	1133.4
Sw(t)	932.3	920.1	909.8	980.6	1067.0	1079.4	1064.8	1049.3	1042.6	1017.5	999.0	962.2	930.5	917.2	904.7	976.5	1065.0	1077.6	1063.3	1047.9
Ro(t)	17.9	18.6	18.1	23.1	32.4	34.8	35.1	28.7	24.8	23.0	20.5	19.0	17.8	18.5	17.8	22.8	32.2	34.6	35.0	28.6
Rg(t)	4.4	4.6	4.4	5.7	7.9	8.5	8.6	7.0	6.1	5.6	5.0	4.6	4.4	4.5	4.4	5.6	7.9	8.5	8.6	7.0
Sg(t)	4378.4	4374.7	4370.8	4368.1	4367.7	4367.9	4368.2	4366.9	4364.7	4362.0	4358.7	4355.1	4351.2	4347.4	4343.5	4340.8	4340.4	4340.6	4340.9	4339.7
Qg(t)	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3
Q(t)	26.3	27.0	26.5	31.4	40.7	43.1	43.5	37.0	33.1	31.3	28.8	27.3	26.1	26.8	26.1	31.0	40.5	42.9	43.3	36.8
E(t)	69.1	92.1	94.8	93.1	101.2	107.9	125.1	85.2	51.2	54.5	41.3	55.3	69.4	92.7	95.1	93.0	101.4	108.4	125.5	85.5

	2028								2029											
	701	702	703	704	705	706	707	708	709	710	711	712	713	714	715	716	717	718	719	720
	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
P(t)	75.4	58.0	48.5	42.2	59.7	101.8	102.6	193.9	232.0	164.4	155.6	105.9	75.3	58.0	48.5	42.2	59.6	101.2	100.4	194.5
PE(t)	80.7	87.7	68.2	94.1	121.3	162.9	169.0	153.0	152.9	161.5	187.8	132.1	81.1	88.1	68.5	94.5	122.1	164.5	170.6	153.5
W(t)	1123.2	1099.1	1064.5	1039.8	1020.5	1030.5	1016.9	1093.4	1204.5	1227.5	1231.3	1167.8	1121.8	1097.6	1063.0	1038.3	1018.9	1028.0	1011.8	1088.9
Y(t)	1092.5	1070.6	1039.0	1016.3	998.4	1007.6	995.0	1065.5	1164.6	1184.6	1187.9	1132.3	1091.2	1069.3	1037.7	1014.9	996.9	1005.3	990.3	1061.4
Sw(t)	1041.1	1016.0	997.6	960.8	928.7	914.3	899.5	972.5	1063.1	1075.7	1061.9	1046.5	1039.6	1014.5	996.1	959.3	926.8	911.3	894.4	968.4
Ro(t)	24.7	22.8	20.4	18.9	17.7	18.3	17.5	22.4	32.0	34.5	34.9	28.5	24.6	22.7	20.3	18.8	17.7	18.2	17.3	22.1
Rg(t)	6.0	5.6	5.0	4.6	4.3	4.5	4.3	5.5	7.8	8.4	8.5	7.0	6.0	5.6	5.0	4.6	4.3	4.5	4.2	5.4
Sg(t)	4337.5	4334.8	4331.6	4327.9	4324.0	4320.3	4316.4	4313.6	4313.3	4313.5	4313.8	4312.6	4310.4	4307.7	4304.5	4300.9	4297.1	4293.3	4289.4	4286.7
Qg(t)	8.3	8.3	8.3	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2
Q(t)	32.9	31.1	28.7	27.1	26.0	26.6	25.8	30.6	40.2	42.7	43.1	36.7	32.8	30.9	28.5	27.0	25.8	26.4	25.4	30.3
E(t)	51.4	54.6	41.4	55.5	69.7	93.4	95.5	93.0	101.6	108.9	126.0	85.9	51.6	54.8	41.6	55.7	70.1	94.0	95.9	93.0

Appendix D (Continued)

Table D10. (Continued)

	2030 721 J	722 F	723 M	724 A	725 M	726 J	727 J	728 A	729 S	730 O	731 N	732 D	2031 733 J	734 F	735 M	736 A	737 M	738 J	739 J	740 A
P(t)	234.1	164.8	156.3	106.1	75.3	58.0	48.5	42.2	59.5	100.5	98.3	195.1	236.1	165.2	157.0	106.4	75.2	58.0	48.5	42.3
PE(t)	153.4	162.5	188.7	132.8	81.5	88.4	68.7	94.9	122.9	166.1	172.1	154.1	153.9	163.5	189.6	133.5	81.9	88.7	69.0	95.3
W(t)	1202.5	1213.8	1208.1	1137.3	1086.0	1057.5	1019.9	992.6	971.6	979.4	961.2	1039.8	1155.3	1177.3	1180.4	1116.1	1068.4	1042.5	1006.8	981.1
Y(t)	1150.6	1160.0	1155.3	1094.9	1049.8	1024.5	990.6	965.8	946.5	953.7	937.0	1008.6	1110.5	1129.3	1131.9	1076.4	1034.3	1011.0	978.7	955.3
Sw(t)	1049.0	1051.9	1031.2	1010.7	999.5	971.4	950.4	912.1	878.9	862.9	844.7	919.2	1012.2	1023.4	1009.7	993.2	984.5	958.4	938.9	902.0
Ro(t)	43.3	44.8	44.0	35.3	30.1	27.5	24.4	22.4	20.9	21.5	20.2	26.0	37.4	40.0	40.4	33.1	28.5	26.2	23.4	21.6
Rg(t)	8.7	9.0	8.8	7.1	6.0	5.5	4.9	4.5	4.2	4.3	4.0	5.2	7.5	8.0	8.1	6.6	5.7	5.2	4.7	4.3
Sg(t)	4286.9	4287.5	4288.0	4286.6	4284.3	4281.4	4277.9	4274.1	4269.9	4265.9	4261.6	4258.5	4257.6	4257.3	4257.1	4255.4	4252.7	4249.7	4246.1	4242.1
Qg(t)	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3
Q(t)	51.7	53.2	52.4	43.7	38.5	35.9	32.8	30.7	29.3	29.8	28.6	34.3	45.7	48.4	48.7	41.4	36.8	34.5	31.7	29.9
E(t)	101.5	108.1	124.1	84.2	50.3	53.1	40.2	53.7	67.6	90.8	92.3	89.4	98.3	105.9	122.1	83.2	49.8	52.6	39.9	53.3

	2031 741 S	742 O	743 N	744 D	2032 745 J	746 F	747 M	748 A	749 M	750 J	751 J	752 A	753 S	754 O	755 N	756 D	2033 757 J	758 F	759 M	760 A
P(t)	59.4	99.9	96.2	195.7	238.2	165.6	157.6	106.7	75.1	58.0	48.5	42.3	59.3	99.2	94.2	196.4	240.3	165.9	158.3	106.9
PE(t)	123.8	167.7	173.7	154.7	154.4	164.5	190.5	134.3	82.3	89.1	69.3	95.8	124.6	169.3	175.3	155.2	154.9	165.5	191.4	135.0
W(t)	961.3	969.6	950.1	1030.4	1149.4	1172.7	1176.9	1113.2	1065.6	1039.9	1004.4	978.9	959.0	966.5	944.7	1025.7	1147.3	1171.2	1175.7	1112.0
Y(t)	937.1	944.6	926.7	1000.1	1105.3	1125.4	1128.9	1073.9	1031.7	1008.6	976.5	953.2	934.9	941.8	921.7	995.9	1103.6	1124.0	1127.9	1072.9
Sw(t)	869.7	853.9	834.7	911.2	1007.2	1019.2	1006.5	990.4	981.8	955.9	936.6	899.8	867.3	850.5	829.4	907.0	1005.2	1017.4	1005.1	989.1
Ro(t)	20.2	20.8	19.5	25.3	36.7	39.5	40.0	32.8	28.2	26.0	23.2	21.4	20.1	20.6	19.2	24.9	36.5	39.3	39.8	32.7
Rg(t)	4.0	4.2	3.9	5.1	7.3	7.9	8.0	6.6	5.6	5.2	4.6	4.3	4.0	4.1	3.8	5.0	7.3	7.9	8.0	6.5
Sg(t)	4237.9	4233.7	4229.4	4226.2	4225.3	4224.9	4224.6	4222.9	4220.3	4217.3	4213.7	4209.8	4205.6	4201.5	4197.1	4193.9	4193.0	4192.6	4192.4	4190.7
Qg(t)	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2
Q(t)	28.5	29.1	27.8	33.5	45.0	47.7	48.2	41.0	36.5	34.3	31.5	29.6	28.3	28.8	27.4	33.1	44.7	47.5	48.0	40.8
E(t)	67.3	90.7	92.0	89.0	98.2	106.1	122.4	83.4	49.9	52.7	39.9	53.4	67.6	91.3	92.3	88.9	98.3	106.6	122.8	83.8

Appendix D (Continued)

Table D10. (Continued)

	2033 761 M	762 J	763 J	764 A	765 S	766 O	767 N	768 D	2034 769 J	770 F	771 M	772 A	773 M	774 J	775 J	776 A	777 S	778 O	779 N	780 D
P(t)	75.1	58.1	48.5	42.3	59.2	98.6	92.2	197.0	242.4	166.3	159.0	107.2	75.0	58.1	48.5	42.3	59.1	97.9	90.3	197.6
PE(t)	82.7	89.4	69.6	96.2	125.5	171.0	176.9	155.8	155.5	166.5	192.3	135.8	83.1	89.8	69.9	96.6	126.4	172.7	178.6	156.4
W(t)	1064.2	1038.4	1003.0	977.5	957.5	964.1	939.9	1021.5	1145.7	1169.9	1174.9	1111.1	1062.9	1037.1	1001.7	976.2	956.0	961.8	935.1	1017.4
Y(t)	1030.4	1007.4	975.2	951.9	933.5	939.6	917.2	992.1	1102.1	1123.0	1127.2	1072.0	1029.3	1006.2	974.0	950.7	932.2	937.5	912.8	988.3
Sw(t)	980.4	954.5	935.2	898.3	865.6	847.6	824.5	903.2	1003.6	1015.8	1003.9	987.8	979.0	953.2	933.9	897.0	863.8	844.8	819.7	899.5
Ro(t)	28.1	25.9	23.1	21.3	20.0	20.4	18.9	24.5	36.3	39.1	39.7	32.6	28.0	25.8	23.0	21.2	19.9	20.3	18.6	24.2
Rg(t)	5.6	5.2	4.6	4.3	4.0	4.1	3.8	4.9	7.3	7.8	7.9	6.5	5.6	5.2	4.6	4.2	4.0	4.1	3.7	4.8
Sg(t)	4188.2	4185.2	4181.6	4177.7	4173.6	4169.5	4165.1	4161.9	4161.0	4160.7	4160.5	4158.9	4156.4	4153.4	4149.9	4146.1	4142.0	4137.9	4133.6	4130.3
Qg(t)	8.2	8.2	8.2	8.2	8.2	8.2	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
Q(t)	36.3	34.1	31.3	29.5	28.1	28.6	27.0	32.7	44.4	47.2	47.9	40.7	36.1	33.9	31.2	29.3	28.0	28.4	26.7	32.3
E(t)	50.1	52.8	40.0	53.6	68.0	92.0	92.7	88.9	98.5	107.2	123.3	84.2	50.2	53.0	40.1	53.8	68.3	92.6	93.1	88.8
	2035 781 J	782 F	783 M	784 A	785 M	786 J	787 J	788 A	789 S	790 O	791 N	792 D	2036 793 J	794 F	795 M	796 A	797 M	798 J	799 J	800 A
P(t)	244.6	166.7	159.7	107.5	75.0	58.1	48.5	42.4	58.9	97.3	88.4	198.3	246.7	167.1	160.4	107.7	74.9	58.1	48.5	42.4
PE(t)	156.0	167.5	193.3	136.5	83.5	90.2	70.2	97.1	127.2	174.5	180.2	156.9	156.5	168.6	194.2	137.3	83.9	90.5	70.4	97.5
W(t)	1144.1	1168.7	1174.0	1110.1	1061.6	1035.8	1000.3	974.9	954.6	959.4	930.4	1013.2	1142.5	1167.5	1173.2	1109.2	1060.3	1034.5	999.0	973.6
Y(t)	1100.7	1121.9	1126.5	1071.2	1028.1	1005.0	972.8	949.6	930.8	935.3	908.4	984.5	1099.4	1120.9	1125.7	1070.4	1027.0	1003.8	971.6	948.4
Sw(t)	1002.0	1014.3	1002.7	986.6	977.7	951.9	932.6	895.6	862.1	842.0	815.0	895.7	1000.5	1012.7	1001.5	985.4	976.4	950.6	931.2	894.3
Ro(t)	36.1	39.0	39.6	32.5	27.9	25.7	22.9	21.1	19.8	20.1	18.3	23.9	35.9	38.8	39.5	32.4	27.8	25.6	22.8	21.1
Rg(t)	7.2	7.8	7.9	6.5	5.6	5.1	4.6	4.2	4.0	4.0	3.7	4.8	7.2	7.8	7.9	6.5	5.6	5.1	4.6	4.2
Sg(t)	4129.5	4129.2	4129.1	4127.5	4125.0	4122.1	4118.6	4114.8	4110.7	4106.7	4102.4	4099.1	4098.3	4098.1	4098.0	4096.4	4094.0	4091.1	4087.7	4083.9
Qg(t)	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0
Q(t)	44.2	47.0	47.7	40.5	35.9	33.7	31.0	29.2	27.8	28.1	26.3	31.9	43.9	46.8	47.5	40.4	35.8	33.6	30.8	29.0
E(t)	98.7	107.7	123.8	84.5	50.4	53.1	40.2	53.9	68.7	93.3	93.5	88.8	98.9	108.2	124.3	84.9	50.6	53.3	40.4	54.1

Appendix D (Continued)

Table D10. (Continued)

	2036 801 S	802 O	803 N	804 D	2037 805 J	806 F	807 M	808 A	809 M	810 J	811 J	812 A	813 S	814 O	815 N	816 D	2038 817 J	818 F	819 M	820 A
P(t)	58.8	96.7	86.5	198.9	248.9	167.5	161.1	108.0	74.8	58.2	48.5	42.4	58.7	96.0	84.7	199.6	251.1	167.8	161.9	108.3
PE(t)	128.1	176.3	182.0	157.5	157.1	169.6	195.2	138.0	84.3	90.9	70.7	98.0	129.0	178.1	183.7	158.1	157.6	170.7	196.1	138.8
W(t)	953.1	957.1	925.7	1009.1	1140.9	1166.4	1172.3	1108.3	1059.0	1033.2	997.7	972.3	951.6	954.7	921.0	1005.0	1139.4	1165.2	1171.5	1107.3
Y(t)	929.4	933.1	904.0	980.8	1098.1	1120.0	1125.0	1069.5	1025.9	1002.6	970.4	947.2	928.1	931.0	899.7	977.1	1096.7	1119.0	1124.3	1068.7
Sw(t)	860.4	839.1	810.2	892.0	998.9	1011.2	1000.3	984.2	975.1	949.2	929.9	892.9	858.7	836.3	805.4	888.3	997.4	1009.6	999.0	983.0
Ro(t)	19.7	20.0	18.0	23.6	35.7	38.7	39.4	32.3	27.6	25.5	22.7	21.0	19.6	19.8	17.7	23.3	35.6	38.6	39.3	32.2
Rg(t)	3.9	4.0	3.6	4.7	7.2	7.7	7.9	6.5	5.5	5.1	4.6	4.2	3.9	4.0	3.5	4.7	7.1	7.7	7.9	6.4
Sg(t)	4079.9	4075.9	4071.6	4068.3	4067.5	4067.3	4067.3	4065.8	4063.3	4060.5	4057.1	4053.4	4049.4	4045.5	4041.1	4037.9	4037.1	4036.9	4036.9	4035.4
Qg(t)	8.0	8.0	8.0	8.0	8.0	8.0	8.0	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9
Q(t)	27.7	27.9	26.0	31.5	43.7	46.6	47.4	40.2	35.6	33.4	30.7	28.9	27.5	27.7	25.6	31.2	43.5	46.4	47.2	40.1
E(t)	69.0	94.0	93.8	88.8	99.1	108.8	124.8	85.3	50.8	53.4	40.5	54.3	69.4	94.7	94.2	88.7	99.3	109.3	125.3	85.7

	2038 821 M	822 J	823 J	824 A	825 S	826 O	827 N	828 D	2039 829 J	830 F	831 M	832 A	833 M	834 J	835 J	836 A	837 S	838 O	839 N	840 D
P(t)	74.8	58.2	48.5	42.4	58.6	95.4	82.9	200.2	272.7	168.7	166.5	109.4	74.6	58.2	48.5	42.6	58.4	94.7	90.3	203.9
PE(t)	84.8	91.3	71.0	98.5	130.0	179.9	185.5	158.7	159.6	171.9	199.7	141.1	86.8	92.2	72.5	100.5	132.9	188.5	191.5	160.9
W(t)	1057.8	1031.9	996.4	971.0	950.1	952.4	916.3	1000.9	1157.3	1178.9	1185.9	1117.2	1064.2	1036.3	999.5	973.1	950.5	950.5	917.8	1003.0
Y(t)	1024.7	1001.5	969.2	946.0	926.7	928.8	895.3	973.3	1112.2	1130.6	1136.6	1077.4	1030.5	1005.4	972.0	947.8	927.1	927.0	896.8	975.2
Sw(t)	973.7	947.9	928.6	891.5	856.9	833.4	800.7	884.6	1010.2	1019.4	1007.8	989.6	978.0	951.1	930.5	892.2	855.8	827.6	799.1	885.2
Ro(t)	27.5	25.4	22.7	20.9	19.5	19.7	17.5	23.0	37.6	40.2	41.1	33.2	28.1	25.7	22.9	21.0	19.5	19.5	17.6	23.1
Rg(t)	5.5	5.1	4.5	4.2	3.9	3.9	3.5	4.6	7.5	8.0	8.2	6.6	5.6	5.1	4.6	4.2	3.9	3.9	3.5	4.6
Sg(t)	4033.1	4030.3	4026.9	4023.2	4019.3	4015.4	4011.0	4007.8	4007.5	4007.7	4008.1	4006.9	4004.7	4002.0	3998.8	3995.2	3991.3	3987.4	3983.1	3980.0
Qg(t)	7.9	7.9	7.9	7.9	7.9	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
Q(t)	35.4	33.2	30.5	28.7	27.4	27.5	25.3	30.8	45.4	48.1	48.9	41.0	35.9	33.5	30.7	28.8	27.3	27.3	25.3	30.9
E(t)	51.0	53.6	40.6	54.5	69.8	95.4	94.6	88.7	101.9	111.2	128.8	87.8	52.5	54.3	41.5	55.7	71.3	99.5	97.7	90.1

Appendix D (Continued)

Table D10. (Continued)

	2040												2041							
	841	842	843	844	845	846	847	848	849	850	851	852	853	854	855	856	857	858	859	860
	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A
P(t)	275.1	169.1	167.2	109.7	74.5	58.3	48.5	42.6	58.3	94.1	88.4	204.6	275.3	168.4	167.9	109.8	74.4	58.3	48.5	42.6
PE(t)	160.2	173.0	200.7	141.9	87.2	92.6	72.8	101.0	133.9	190.5	193.4	161.5	161.7	175.3	203.0	143.6	87.9	93.2	73.3	101.7
W(t)	1092.3	1111.0	1115.8	1046.0	991.0	960.5	922.4	894.5	872.1	873.0	841.6	930.9	1089.4	1107.3	1112.4	1042.3	987.0	956.9	919.0	891.4
Y(t)	1038.6	1054.1	1058.1	999.3	951.5	924.7	890.6	865.5	845.1	846.0	817.2	898.3	1036.1	1051.0	1055.3	996.1	948.1	921.5	887.6	862.7
Sw(t)	941.9	948.6	936.3	916.4	902.2	873.9	851.9	813.8	778.9	753.2	726.3	814.1	938.9	944.5	932.4	912.6	898.6	870.6	848.8	810.8
Ro(t)	47.0	49.7	50.4	40.8	34.4	31.3	27.7	25.3	23.5	23.6	21.3	28.5	46.6	49.1	49.9	40.4	34.0	30.9	27.4	25.1
Rg(t)	6.8	7.2	7.3	5.9	5.0	4.5	4.0	3.7	3.4	3.4	3.1	4.1	6.8	7.1	7.2	5.9	4.9	4.5	4.0	3.6
Sg(t)	4359.4	4359.6	4359.9	4358.8	4356.8	4354.4	4351.4	4348.1	4344.6	4341.0	4337.2	4334.3	4334.1	4334.3	4334.6	4333.5	4331.5	4329.0	4326.0	4322.8
Qg(t)	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	6.9	6.9	6.9
Q(t)	54.0	56.7	57.4	47.8	41.4	38.3	34.7	32.3	30.5	30.6	28.2	35.4	53.5	56.1	56.8	47.3	41.0	37.9	34.4	32.0
E(t)	96.6	105.5	121.9	82.8	49.3	50.8	38.7	51.7	66.2	92.7	90.9	84.2	97.3	106.5	122.8	83.5	49.5	50.9	38.8	51.9

	2041				2042												2043			
	861	862	863	864	865	866	867	868	869	870	871	872	873	874	875	876	877	878	879	880
	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A
P(t)	58.2	92.9	78.3	204.9	275.5	167.8	168.5	110.0	74.4	58.3	48.5	42.5	58.1	91.8	69.4	205.2	275.8	167.2	169.2	110.1
PE(t)	135.3	193.4	196.4	163.2	163.2	177.7	205.3	145.3	88.6	93.7	73.7	102.5	136.8	196.5	199.5	165.0	164.8	180.1	207.7	147.1
W(t)	946.2	943.8	897.9	985.1	1144.7	1166.0	1174.5	1105.8	1052.3	1025.1	989.2	963.3	940.7	937.2	882.1	970.9	1132.2	1154.6	1164.9	1097.2
Y(t)	923.1	920.9	878.2	958.9	1101.3	1119.6	1126.9	1067.3	1019.8	995.3	962.6	938.9	918.0	914.8	863.4	945.9	1090.4	1109.8	1118.7	1059.8
Sw(t)	850.9	819.6	780.2	869.2	998.2	1006.0	995.8	977.9	966.8	940.7	920.8	882.7	845.4	812.7	765.7	856.4	987.4	995.7	987.2	970.0
Ro(t)	19.3	19.1	16.4	21.9	36.2	38.6	39.7	32.0	27.1	24.8	22.1	20.4	18.9	18.7	15.6	20.9	34.8	37.3	38.5	31.2
Rg(t)	3.9	3.8	3.3	4.4	7.2	7.7	7.9	6.4	5.4	5.0	4.4	4.1	3.8	3.7	3.1	4.2	7.0	7.5	7.7	6.2
Sg(t)	3936.8	3932.9	3928.6	3925.3	3924.8	3924.9	3925.1	3923.9	3921.6	3918.9	3915.7	3912.1	3908.3	3904.4	3899.9	3896.4	3895.8	3895.6	3895.7	3894.3
Qg(t)	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6
Q(t)	27.0	26.8	24.1	29.5	43.8	46.3	47.4	39.7	34.7	32.5	29.8	28.0	26.6	26.3	23.2	28.5	42.4	44.9	46.1	38.8
E(t)	72.3	101.3	98.0	89.8	103.1	113.6	131.1	89.4	53.0	54.6	41.8	56.2	72.6	102.1	97.7	89.5	103.0	114.1	131.6	89.8

Appendix D (Continued)

Table D10. (Continued)

	2043 881 M	882 J	883 J	884 A	885 S	886 O	887 N	888 D	2044 889 J	890 F	891 M	892 A	893 M	894 J	895 J	896 A	897 S	898 O	899 N	900 D
P(t)	74.3	58.4	48.5	42.5	58.0	90.7	61.6	205.6	276.0	166.5	169.9	110.2	74.2	58.4	48.5	42.5	57.9	89.6	54.6	205.9
PE(t)	89.3	94.3	74.2	103.3	138.4	199.6	202.6	166.8	166.4	182.5	210.2	148.9	90.1	94.8	74.7	104.1	139.9	202.8	205.9	168.6
W(t)	1044.3	1017.9	982.7	957.4	935.1	930.5	867.2	957.4	1120.2	1143.5	1155.6	1088.8	1036.3	1010.8	976.2	951.4	929.4	923.7	853.1	944.5
Y(t)	1012.6	988.8	956.7	933.4	912.8	908.5	849.4	933.4	1080.0	1100.3	1110.7	1052.4	1005.5	982.3	950.8	927.9	907.5	902.3	836.1	921.5
Sw(t)	959.6	934.2	914.9	877.1	839.8	805.6	751.8	844.2	977.0	985.7	978.6	962.1	952.4	927.8	908.9	871.5	834.2	798.5	738.6	832.5
Ro(t)	26.4	24.3	21.7	20.0	18.6	18.3	14.8	20.0	33.5	36.0	37.4	30.4	25.7	23.7	21.2	19.6	18.2	17.9	14.1	19.2
Rg(t)	5.3	4.9	4.3	4.0	3.7	3.7	3.0	4.0	6.7	7.2	7.5	6.1	5.1	4.7	4.2	3.9	3.6	3.6	2.8	3.8
Sg(t)	3892.0	3889.3	3886.0	3882.4	3878.6	3874.6	3870.0	3866.5	3865.6	3865.3	3865.2	3863.7	3861.3	3858.5	3855.2	3851.6	3847.8	3843.8	3839.2	3835.5
Qg(t)	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5
Q(t)	34.0	31.9	29.3	27.6	26.2	25.9	22.4	27.5	41.1	43.6	45.0	37.9	33.3	31.3	28.8	27.1	25.8	25.4	21.6	26.7
E(t)	53.1	54.6	41.8	56.3	73.0	102.9	97.6	89.2	103.0	114.6	132.1	90.3	53.1	54.5	41.8	56.4	73.3	103.7	97.5	89.0

	2045 901 J	902 F	903 M	904 A	905 M	906 J	907 J	908 A	909 S	910 O	911 N	912 D	2046 913 J	914 F	915 M	916 A	917 M	918 J	919 J	920 A
P(t)	276.2	165.9	170.5	110.3	74.1	58.4	48.5	42.5	57.8	88.5	48.4	206.2	276.4	165.3	171.2	110.5	74.1	58.4	48.5	42.5
PE(t)	168.0	185.1	212.7	150.7	90.8	95.4	75.1	104.9	141.5	206.1	209.2	170.5	169.7	187.7	215.3	152.6	91.6	96.0	75.6	105.7
W(t)	1108.7	1132.9	1146.5	1080.6	1028.5	1003.7	969.8	945.5	923.7	917.0	839.8	932.3	1097.8	1122.6	1137.6	1072.4	1020.7	996.6	963.4	939.6
Y(t)	1070.0	1091.0	1102.8	1045.1	998.4	975.8	944.9	922.5	902.3	896.0	823.6	910.2	1060.3	1082.1	1095.2	1037.8	991.4	969.4	939.0	917.0
Sw(t)	967.0	975.9	970.2	954.4	945.2	921.3	903.0	866.0	828.6	791.4	726.0	821.4	957.3	966.4	962.0	946.7	938.1	914.9	897.2	860.4
Ro(t)	32.3	34.9	36.4	29.6	25.1	23.2	20.8	19.2	17.9	17.5	13.5	18.4	31.2	33.7	35.4	28.8	24.5	22.7	20.4	18.9
Rg(t)	6.5	7.0	7.3	5.9	5.0	4.6	4.2	3.8	3.6	3.5	2.7	3.7	6.2	6.8	7.1	5.8	4.9	4.5	4.1	3.8
Sg(t)	3834.5	3833.9	3833.7	3832.1	3829.7	3826.8	3823.5	3819.9	3816.0	3812.1	3807.3	3803.6	3802.4	3801.7	3801.4	3799.7	3797.2	3794.3	3791.0	3787.3
Qg(t)	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4
Q(t)	39.8	42.3	43.9	37.1	32.6	30.7	28.3	26.7	25.4	25.0	21.0	25.8	38.7	41.2	42.8	36.3	31.9	30.1	27.8	26.3
E(t)	103.0	115.1	132.6	90.7	53.1	54.5	41.8	56.5	73.7	104.6	97.5	88.8	103.0	115.7	133.2	91.2	53.2	54.5	41.8	56.6

Appendix D (Continued)

Table D10. (Continued)

	2046 921 S	922 O	923 N	924 D	2047 925 J	926 F	927 M	928 A	929 M	930 J	931 J	932 A	933 S	934 O	935 N	936 D	2048 937 J	938 F	939 M	940 A
P(t)	57.7	87.4	42.9	206.6	276.7	164.6	171.9	110.6	74.0	58.5	48.5	42.4	57.6	86.3	38.0	206.9	276.9	164.0	172.6	110.7
PE(t)	143.1	209.5	212.7	172.4	171.4	190.4	217.9	154.6	92.4	96.6	76.1	106.6	144.8	213.0	216.2	174.4	173.2	193.1	220.6	156.6
W(t)	918.1	910.3	827.1	920.6	1087.3	1112.6	1128.9	1064.4	1013.0	989.6	957.0	933.7	912.4	903.5	815.1	909.4	1077.1	1102.8	1120.4	1056.5
Y(t)	897.0	889.7	811.6	899.3	1051.0	1073.3	1087.6	1030.7	984.4	963.0	933.1	911.5	891.7	883.4	800.2	888.9	1042.0	1064.7	1080.2	1023.5
Sw(t)	822.9	784.2	714.0	810.6	947.9	957.0	953.8	939.0	931.1	908.5	891.3	854.8	817.2	777.1	702.5	800.3	938.8	947.8	945.7	931.4
Ro(t)	17.6	17.1	12.9	17.7	30.2	32.7	34.4	28.1	23.9	22.2	20.0	18.5	17.2	16.7	12.4	17.1	29.3	31.7	33.5	27.4
Rg(t)	3.5	3.4	2.6	3.5	6.0	6.5	6.9	5.6	4.8	4.4	4.0	3.7	3.4	3.3	2.5	3.4	5.9	6.3	6.7	5.5
Sg(t)	3783.5	3779.5	3774.7	3770.9	3769.6	3768.7	3768.3	3766.5	3763.9	3761.0	3757.7	3754.0	3750.1	3746.2	3741.3	3737.5	3736.0	3735.1	3734.5	3732.6
Qg(t)	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3
Q(t)	25.0	24.5	20.3	25.1	37.6	40.1	41.8	35.5	31.2	29.5	27.3	25.8	24.6	24.1	19.7	24.4	36.6	39.0	40.8	34.7
E(t)	74.1	105.5	97.6	88.7	103.1	116.3	133.8	91.6	53.3	54.4	41.8	56.7	74.5	106.4	97.7	88.6	103.2	116.9	134.4	92.1

	2048 941 M	942 J	943 J	944 A	945 S	946 O	947 N	948 D	2049 949 J	950 F	951 M	952 A	953 M	954 J	955 J	956 A	957 S	958 O	959 N	960 D
P(t)	73.9	58.5	48.5	42.4	57.5	85.2	33.7	207.2	277.1	163.4	173.3	110.8	73.8	58.5	48.5	42.4	57.4	84.2	29.9	207.5
PE(t)	93.2	97.2	76.6	107.4	146.5	216.6	219.9	176.4	174.9	196.0	223.4	158.6	94.0	97.8	77.1	108.3	148.3	220.4	223.7	178.4
W(t)	1005.4	982.5	950.7	927.8	906.7	896.8	803.5	898.5	1067.3	1093.3	1112.0	1048.6	997.7	975.5	944.3	921.9	901.0	890.0	792.4	888.1
Y(t)	977.4	956.5	927.2	906.0	886.4	877.1	789.2	878.8	1033.3	1056.4	1072.8	1016.5	970.4	950.1	921.3	900.5	881.1	870.8	778.7	869.0
Sw(t)	924.0	902.2	885.4	849.3	811.6	769.8	691.3	790.2	929.9	938.7	937.7	923.9	917.0	895.8	879.5	843.6	805.8	762.6	680.5	780.4
Ro(t)	23.3	21.7	19.5	18.1	16.9	16.4	11.9	16.5	28.4	30.8	32.7	26.7	22.8	21.2	19.1	17.8	16.6	16.0	11.5	15.9
Rg(t)	4.7	4.3	3.9	3.6	3.4	3.3	2.4	3.3	5.7	6.2	6.5	5.4	4.6	4.2	3.8	3.6	3.3	3.2	2.3	3.2
Sg(t)	3730.0	3727.1	3723.7	3720.1	3716.2	3712.2	3707.3	3703.4	3701.8	3700.8	3700.1	3698.2	3695.5	3692.5	3689.2	3685.5	3681.6	3677.6	3672.8	3668.8
Qg(t)	7.3	7.3	7.3	7.3	7.3	7.3	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2
Q(t)	30.6	29.0	26.8	25.4	24.2	23.6	19.2	23.7	35.6	38.0	39.9	34.0	30.0	28.4	26.4	25.0	23.8	23.2	18.6	23.1
E(t)	53.3	54.4	41.8	56.8	74.9	107.3	97.9	88.6	103.3	117.6	135.1	92.6	53.4	54.4	41.8	56.9	75.3	108.2	98.1	88.6

Appendix D (Continued)

Table D10. (Continued)

	2050 961 J	962 F	963 M	964 A	965 M	966 J	967 J	968 A	969 S	970 O	971 N	972 D
P(t)	277.3	162.8	173.9	111.0	73.8	58.6	48.5	42.4	57.3	83.1	26.5	207.9
PE(t)	176.8	198.9	226.2	160.7	94.8	98.4	77.7	109.2	150.1	224.2	227.5	180.6
W(t)	1057.8	1084.0	1103.7	1040.8	990.1	968.5	937.9	915.9	895.3	883.2	781.7	877.9
Y(t)	1024.7	1048.1	1065.5	1009.5	963.4	943.7	915.4	895.0	875.7	864.4	768.5	859.5
Sw(t)	921.2	929.8	929.8	916.3	910.0	889.4	873.5	838.0	800.1	755.2	670.0	770.9
Ro(t)	27.5	29.9	31.8	26.1	22.2	20.7	18.7	17.4	16.3	15.6	11.0	15.4
Rg(t)	5.5	6.0	6.4	5.2	4.4	4.1	3.8	3.5	3.3	3.1	2.2	3.1
Sg(t)	3667.1	3665.9	3665.1	3663.2	3660.5	3657.5	3654.1	3650.4	3646.6	3642.6	3637.7	3633.6
Qg(t)	7.2	7.2	7.2	7.2	7.2	7.1	7.1	7.1	7.1	7.1	7.1	7.1
Q(t)	34.7	37.1	39.0	33.3	29.4	27.9	25.9	24.6	23.4	22.8	18.1	22.5
E(t)	103.5	118.3	135.7	93.1	53.5	54.3	41.8	57.0	75.7	109.2	98.4	88.6

Appendix D (Continued)

Table D11. Water balance output values – rapid growth and A2 scenarios (2010-2050) .

	2010 481 J	482 F	483 M	484 A	485 M	486 J	487 J	488 A	489 S	490 O	491 N	492 D	2011 493 J	494 F	495 M	496 A	497 M	498 J	499 J	500 A
P(t)	292.8	199.5	119.7	100.3	83.1	7.1	55.2	46.8	74.6	113.4	154.9	188.8	198.1	157.8	143.8	101.2	76.4	57.6	48.5	41.8
PE(t)	144.0	145.2	172.7	120.1	74.6	82.2	63.8	87.3	108.4	138.6	145.4	144.0	144.4	145.9	173.4	120.7	74.9	82.5	64.0	87.6
W(t)	1395.0	1432.9	1380.1	1301.9	1260.7	1182.1	1157.3	1139.0	1135.5	1158.2	1200.5	1265.9	1330.2	1292.6	1251.9	1162.9	1105.6	1069.4	1025.9	993.4
Y(t)	1343.1	1373.4	1330.8	1264.3	1228.1	1157.0	1134.2	1117.2	1114.0	1135.0	1173.8	1232.7	1238.2	1210.3	1179.0	1107.0	1058.6	1027.3	989.2	960.2
Sw(t)	1233.4	1260.4	1201.6	1177.6	1175.0	1102.1	1092.2	1061.0	1044.8	1045.6	1077.1	1132.1	1134.8	1108.2	1061.7	1029.2	1011.8	977.4	951.6	910.7
Ro(t)	40.2	46.0	38.1	29.0	25.2	19.4	17.9	16.8	16.7	17.9	20.6	25.7	77.5	69.4	61.5	47.1	39.6	35.4	31.0	28.0
Rg(t)	11.8	13.5	11.2	8.5	7.4	5.7	5.2	4.9	4.9	5.3	6.0	7.5	14.4	12.9	11.4	8.8	7.4	6.6	5.8	5.2
Sg(t)	4806.6	4813.3	4817.8	4819.5	4820.1	4819.0	4817.5	4815.7	4813.8	4812.3	4811.6	4812.4	4812.8	4811.7	4809.2	4804.0	4797.4	4790.1	4781.9	4773.3
Qg(t)	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	14.0	14.0	14.0	14.0	13.9	13.9	13.9	13.9
Q(t)	46.9	52.8	44.9	35.8	32.0	26.2	24.7	23.6	23.4	24.7	27.4	32.4	91.5	83.4	75.5	61.1	53.5	49.3	44.9	41.8
E(t)	109.7	113.0	129.2	86.7	53.0	54.9	42.0	56.2	69.2	89.4	96.7	100.6	103.4	102.1	117.2	77.9	46.8	49.9	37.5	49.5

	2011 501 S	502 O	503 N	504 D	2012 505 J	506 F	507 M	508 A	509 M	510 J	511 J	512 A	513 S	514 O	515 N	516 D	2013 517 J	518 F	519 M	520 A
P(t)	61.6	113.6	147.4	183.5	199.8	158.2	144.4	101.4	76.3	57.6	48.5	41.8	61.5	112.9	144.3	184.1	201.6	158.5	145.0	101.7
PE(t)	109.0	139.8	146.5	144.4	144.8	146.7	174.1	121.3	75.2	82.8	64.2	88.0	109.7	141.0	147.7	144.9	145.3	147.5	174.8	121.9
W(t)	972.4	995.0	1031.1	1093.1	1160.2	1170.4	1163.2	1098.1	1054.2	1026.7	990.1	962.6	945.8	971.4	1007.9	1074.2	1146.7	1160.1	1155.6	1092.2
Y(t)	941.3	961.6	993.8	1047.9	1104.8	1113.2	1107.2	1052.2	1014.1	989.9	957.3	932.5	917.3	940.4	973.2	1031.6	1093.5	1104.7	1100.9	1047.1
Sw(t)	881.3	883.7	909.6	960.4	1012.2	1018.8	996.7	977.9	969.1	941.6	920.8	884.2	858.5	863.6	890.1	945.1	1001.6	1010.5	990.5	972.8
Ro(t)	26.2	28.1	31.5	38.1	46.7	48.2	47.2	38.7	33.8	31.0	27.7	25.4	24.0	26.1	29.3	36.0	44.9	46.7	46.1	38.0
Rg(t)	4.9	5.2	5.8	7.1	8.7	9.0	8.8	7.2	6.3	5.8	5.1	4.7	4.5	4.8	5.4	6.7	8.3	8.7	8.6	7.1
Sg(t)	4764.3	4755.7	4747.8	4741.1	4736.0	4731.2	4726.3	4719.7	4712.3	4704.4	4695.9	4687.0	4677.9	4669.2	4661.1	4654.3	4649.1	4644.3	4639.4	4633.0
Qg(t)	13.8	13.8	13.8	13.8	13.8	13.7	13.7	13.7	13.7	13.7	13.6	13.6	13.6	13.6	13.5	13.5	13.5	13.5	13.5	13.5
Q(t)	40.0	41.9	45.3	51.9	60.5	61.9	60.9	52.4	47.5	44.7	41.3	39.0	37.6	39.6	42.8	49.5	58.4	60.2	59.6	51.5
E(t)	60.0	77.9	84.2	87.6	92.6	94.4	110.5	74.3	45.1	48.3	36.4	48.3	58.8	76.8	83.1	86.5	91.9	94.2	110.4	74.3

Appendix D (Continued)

Table D11. (Continued)

	2013 521 M	522 J	523 J	524 A	525 S	526 O	527 N	528 D	2014 529 J	530 F	531 M	532 A	533 M	534 J	535 J	536 A	537 S	538 O	539 N	540 D
P(t)	76.3	57.6	48.5	41.8	61.4	112.2	141.2	184.7	203.4	158.9	145.7	101.9	76.2	57.7	48.5	41.8	61.3	111.5	138.3	185.3
PE(t)	75.5	83.1	64.5	88.3	110.4	142.2	148.9	145.4	145.7	148.3	175.6	122.4	75.9	83.3	64.7	88.7	111.0	143.4	150.1	145.8
W(t)	1049.1	1022.2	986.2	959.1	942.5	967.5	1001.1	1068.6	1143.7	1157.9	1154.0	1090.9	1047.6	1020.8	984.8	957.8	941.1	965.3	995.6	1064.1
Y(t)	1009.6	985.9	953.7	929.4	914.3	937.0	967.1	1026.7	1091.0	1102.9	1099.6	1046.0	1008.3	984.7	952.5	928.2	913.0	934.9	962.2	1022.7
Sw(t)	964.6	937.7	917.3	881.1	855.3	859.8	883.9	940.4	999.0	1008.4	988.9	971.4	963.2	936.3	916.0	879.8	853.8	857.3	878.8	936.5
Ro(t)	33.3	30.6	27.3	25.1	23.8	25.8	28.7	35.4	44.5	46.4	45.9	37.9	33.1	30.5	27.2	25.0	23.7	25.6	28.2	34.9
Rg(t)	6.2	5.7	5.1	4.7	4.4	4.8	5.3	6.6	8.3	8.6	8.5	7.0	6.2	5.7	5.1	4.6	4.4	4.8	5.2	6.5
Sg(t)	4625.7	4618.0	4609.7	4601.0	4592.1	4583.6	4575.6	4568.9	4563.9	4559.3	4554.6	4548.4	4541.4	4533.9	4525.8	4517.3	4508.6	4500.3	4492.5	4485.9
Qg(t)	13.4	13.4	13.4	13.4	13.3	13.3	13.3	13.3	13.3	13.2	13.2	13.2	13.2	13.2	13.1	13.1	13.1	13.1	13.0	13.0
Q(t)	46.7	44.0	40.7	38.4	37.1	39.1	41.9	48.6	57.7	59.7	59.1	51.1	46.3	43.7	40.4	38.1	36.8	38.7	41.2	47.9
E(t)	45.0	48.3	36.4	48.3	59.0	77.1	83.2	86.3	91.9	94.5	110.7	74.6	45.2	48.4	36.5	48.4	59.2	77.6	83.4	86.3

	2015 541 J	542 F	543 M	544 A	545 M	546 J	547 J	548 A	549 S	550 O	551 N	552 D	2016 553 J	554 F	555 M	556 A	557 M	558 J	559 J	560 A
P(t)	205.2	159.3	146.3	102.2	76.2	57.7	48.5	41.9	61.2	110.7	135.3	185.9	207.0	159.6	146.9	102.5	76.1	57.7	48.5	41.9
PE(t)	146.2	149.1	176.4	123.0	76.2	83.6	64.9	89.0	111.7	144.7	151.3	146.3	146.6	149.9	177.1	123.6	76.5	83.9	65.2	89.4
W(t)	1141.6	1156.4	1153.0	1089.9	1046.5	1019.7	983.7	956.8	939.9	963.1	990.3	1059.7	1139.7	1155.0	1152.1	1089.0	1045.3	1018.6	982.6	955.7
Y(t)	1089.2	1101.6	1098.8	1045.2	1007.3	983.7	951.5	927.2	911.9	933.0	957.4	1018.9	1087.6	1100.4	1098.0	1044.4	1006.3	982.7	950.5	926.3
Sw(t)	997.2	1006.7	987.7	970.3	962.0	935.2	914.9	878.7	852.4	854.9	873.8	932.7	995.4	1005.1	986.6	969.2	960.9	934.1	913.8	877.6
Ro(t)	44.2	46.2	45.7	37.7	33.0	30.4	27.1	24.9	23.6	25.4	27.7	34.4	43.9	46.0	45.6	37.6	32.9	30.3	27.0	24.8
Rg(t)	8.2	8.6	8.5	7.0	6.1	5.6	5.0	4.6	4.4	4.7	5.1	6.4	8.2	8.6	8.5	7.0	6.1	5.6	5.0	4.6
Sg(t)	4481.1	4476.7	4472.2	4466.2	4459.4	4452.1	4444.3	4436.0	4427.5	4419.4	4411.8	4405.3	4400.7	4396.5	4392.2	4386.5	4379.9	4372.8	4365.1	4357.1
Qg(t)	13.0	13.0	13.0	13.0	13.0	12.9	12.9	12.9	12.9	12.8	12.8	12.8	12.8	12.8	12.8	12.7	12.7	12.7	12.7	12.7
Q(t)	57.2	59.2	58.7	50.7	46.0	43.3	40.0	37.8	36.4	38.2	40.5	47.2	56.7	58.8	58.4	50.4	45.6	43.0	39.7	37.5
E(t)	92.1	94.9	111.0	74.9	45.3	48.5	36.6	48.6	59.5	78.1	83.6	86.2	92.2	95.3	111.4	75.2	45.5	48.6	36.7	48.7

Appendix D (Continued)

Table D11. (Continued)

	2016 561 S	562 O	563 N	564 D	2017 565 J	566 F	567 M	568 A	569 M	570 J	571 J	572 A	573 S	574 O	575 N	576 D	2018 577 J	578 F	579 M	580 A
P(t)	61.1	110.0	132.5	186.5	208.8	160.0	147.6	102.7	76.0	57.7	48.5	41.9	61.0	109.3	129.7	187.1	210.6	160.3	148.2	103.0
PE(t)	112.4	145.9	152.5	146.8	147.1	150.7	177.9	124.2	76.8	84.2	65.4	89.8	113.1	147.2	153.8	147.3	147.5	151.6	178.7	124.9
W(t)	938.6	961.0	985.0	1055.3	1137.7	1153.6	1151.2	1088.1	1044.2	1017.4	981.4	954.6	937.4	958.9	979.8	1051.0	1135.8	1152.2	1150.3	1087.3
Y(t)	910.8	931.1	952.7	1015.1	1086.0	1099.3	1097.2	1043.6	1005.3	981.7	949.5	925.3	909.7	929.2	948.0	1011.3	1084.4	1098.1	1096.5	1042.9
Sw(t)	851.0	852.5	868.8	928.9	993.6	1003.6	985.4	968.2	959.7	933.0	912.7	876.5	849.6	850.1	863.9	925.2	991.9	1002.0	984.3	967.1
Ro(t)	23.5	25.2	27.2	33.9	43.7	45.8	45.5	37.5	32.8	30.2	26.9	24.7	23.4	25.1	26.8	33.5	43.4	45.6	45.4	37.4
Rg(t)	4.4	4.7	5.1	6.3	8.1	8.5	8.5	7.0	6.1	5.6	5.0	4.6	4.3	4.7	5.0	6.2	8.1	8.5	8.4	7.0
Sg(t)	4348.8	4340.9	4333.4	4327.1	4322.7	4318.6	4314.6	4309.0	4302.6	4295.7	4288.3	4280.5	4272.4	4264.7	4257.3	4251.2	4246.9	4243.0	4239.2	4233.8
Qg(t)	12.6	12.6	12.6	12.6	12.6	12.5	12.5	12.5	12.5	12.5	12.5	12.4	12.4	12.4	12.4	12.3	12.3	12.3	12.3	12.3
Q(t)	36.1	37.8	39.8	46.5	56.2	58.4	58.0	50.1	45.3	42.6	39.4	37.2	35.8	37.5	39.2	45.8	55.8	58.0	57.7	49.7
E(t)	59.8	78.6	83.9	86.2	92.3	95.7	111.8	75.5	45.6	48.7	36.8	48.8	60.1	79.1	84.1	86.1	92.5	96.1	112.2	75.8
	2018 581 M	582 J	583 J	584 A	585 S	586 O	587 N	588 D	2019 589 J	590 F	591 M	592 A	593 M	594 J	595 J	596 A	597 S	598 O	599 N	600 D
P(t)	76.0	57.7	48.5	41.9	60.8	108.6	127.0	187.7	212.5	160.7	148.9	103.2	75.9	57.8	48.5	42.0	60.7	107.9	124.3	188.3
PE(t)	77.2	84.5	65.6	90.1	113.8	148.5	155.1	147.8	148.0	152.4	179.5	125.5	77.5	84.8	65.9	90.5	114.5	149.9	156.4	148.3
W(t)	1043.1	1016.3	980.3	953.6	936.2	956.8	974.7	1046.7	1134.0	1150.9	1149.4	1086.4	1041.9	1015.2	979.2	952.5	934.9	954.7	969.6	1042.5
Y(t)	1004.3	980.7	948.5	924.3	908.5	927.3	943.4	1007.6	1082.8	1097.0	1095.7	1042.1	1003.3	979.7	947.5	923.4	907.4	925.4	938.8	1003.8
Sw(t)	958.6	931.8	911.6	875.3	848.2	847.7	859.0	921.5	990.2	1000.5	983.2	966.0	957.4	930.7	910.5	874.2	846.8	845.3	854.2	917.8
Ro(t)	32.7	30.1	26.8	24.6	23.3	24.9	26.4	33.0	43.2	45.4	45.2	37.3	32.6	30.0	26.7	24.6	23.2	24.7	25.9	32.6
Rg(t)	6.1	5.6	5.0	4.6	4.3	4.6	4.9	6.1	8.0	8.4	8.4	6.9	6.0	5.6	5.0	4.6	4.3	4.6	4.8	6.1
Sg(t)	4227.6	4220.9	4213.7	4206.0	4198.2	4190.6	4183.4	4177.4	4173.3	4169.6	4165.9	4160.8	4154.8	4148.3	4141.2	4133.8	4126.1	4118.7	4111.6	4105.7
Qg(t)	12.3	12.3	12.2	12.2	12.2	12.2	12.2	12.1	12.1	12.1	12.1	12.1	12.1	12.0	12.0	12.0	12.0	12.0	11.9	11.9
Q(t)	44.9	42.3	39.1	36.9	35.5	37.1	38.5	45.2	55.3	57.6	57.3	49.4	44.6	42.0	38.8	36.6	35.2	36.7	37.9	44.5
E(t)	45.8	48.8	36.9	49.0	60.3	79.6	84.4	86.1	92.6	96.5	112.6	76.1	45.9	48.9	37.0	49.1	60.6	80.1	84.6	86.0

Appendix D (Continued)

Table D11. (Continued)

	2020 601 J	602 F	603 M	604 A	605 M	606 J	607 J	608 A	609 S	610 O	611 N	612 D	2021 613 J	614 F	615 M	616 A	617 M	618 J	619 J	620 A
P(t)	214.4	161.1	149.6	103.5	75.9	57.8	48.5	42.0	60.6	107.2	121.7	188.9	216.3	161.4	150.2	103.7	75.8	57.8	48.5	42.0
PE(t)	148.5	153.3	180.2	126.1	77.9	85.2	66.1	90.9	115.2	151.2	157.7	148.8	149.0	154.2	181.1	126.8	78.2	85.5	66.4	91.3
W(t)	1132.2	1149.6	1148.5	1085.5	1040.8	1014.1	978.1	951.4	933.7	952.6	964.5	1038.3	1130.4	1148.3	1147.7	1084.7	1039.7	1013.0	977.0	950.3
Y(t)	1081.2	1095.9	1095.0	1041.4	1002.3	978.7	946.5	922.4	906.3	923.5	934.2	1000.1	1079.7	1094.8	1094.3	1040.6	1001.4	977.7	945.5	921.4
Sw(t)	988.5	999.0	982.0	965.0	956.3	929.6	909.4	873.1	845.4	842.8	849.3	914.1	986.8	997.4	980.9	963.9	955.2	928.5	908.3	872.0
Ro(t)	42.9	45.3	45.1	37.2	32.4	29.8	26.6	24.5	23.1	24.6	25.5	32.2	42.7	45.1	45.0	37.1	32.3	29.7	26.6	24.4
Rg(t)	8.0	8.4	8.4	6.9	6.0	5.5	5.0	4.5	4.3	4.6	4.7	6.0	7.9	8.4	8.4	6.9	6.0	5.5	4.9	4.5
Sg(t)	4101.8	4098.3	4094.8	4089.8	4084.0	4077.7	4070.8	4063.6	4056.1	4048.9	4041.9	4036.2	4032.4	4029.1	4025.7	4020.9	4015.3	4009.2	4002.5	3995.4
Qg(t)	11.9	11.9	11.9	11.9	11.9	11.8	11.8	11.8	11.8	11.8	11.7	11.7	11.7	11.7	11.7	11.7	11.7	11.6	11.6	11.6
Q(t)	54.9	57.2	57.0	49.1	44.3	41.7	38.5	36.3	34.9	36.3	37.3	43.9	54.4	56.8	56.7	48.8	44.0	41.4	38.2	36.0
E(t)	92.8	96.9	113.0	76.4	46.1	49.1	37.1	49.3	60.9	80.6	84.9	86.0	92.9	97.4	113.4	76.7	46.2	49.2	37.2	49.4

	2021 621 S	622 O	623 N	624 D	2022 625 J	626 F	627 M	628 A	629 M	630 J	631 J	632 A	633 S	634 O	635 N	636 D	2023 637 J	638 F	639 M	640 A
P(t)	60.5	106.5	119.1	189.5	218.2	161.8	150.9	104.0	75.7	57.8	48.5	42.0	60.4	105.8	116.6	190.1	220.1	162.2	151.5	104.3
PE(t)	115.9	152.6	159.0	149.3	149.4	155.0	181.9	127.4	78.6	85.8	66.6	91.7	116.7	154.0	160.4	149.8	149.9	155.9	182.7	128.0
W(t)	932.5	950.5	959.5	1034.1	1128.6	1147.0	1146.8	1083.8	1038.6	1011.8	975.8	949.2	931.2	948.3	954.5	1029.9	1126.9	1145.7	1146.0	1083.0
Y(t)	905.2	921.5	929.7	996.4	1078.2	1093.7	1093.6	1039.9	1000.4	976.7	944.5	920.4	904.0	919.6	925.2	992.7	1076.8	1092.7	1092.9	1039.1
Sw(t)	843.9	840.4	844.5	910.4	985.2	995.9	979.8	962.8	954.0	927.4	907.2	870.8	842.5	837.9	839.7	906.8	983.6	994.4	978.7	961.8
Ro(t)	23.0	24.4	25.1	31.8	42.5	44.9	44.9	37.0	32.2	29.6	26.5	24.3	22.9	24.2	24.7	31.4	42.3	44.7	44.8	36.9
Rg(t)	4.3	4.5	4.7	5.9	7.9	8.3	8.3	6.9	6.0	5.5	4.9	4.5	4.3	4.5	4.6	5.8	7.9	8.3	8.3	6.9
Sg(t)	3988.1	3981.1	3974.2	3968.6	3965.0	3961.8	3958.6	3954.0	3948.5	3942.6	3936.1	3929.2	3922.1	3915.2	3908.4	3902.9	3899.4	3896.4	3893.5	3889.0
Qg(t)	11.6	11.6	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.4	11.4	11.4	11.4	11.4	11.3	11.3	11.3	11.3	11.3
Q(t)	34.6	36.0	36.7	43.3	54.0	56.4	56.4	48.5	43.7	41.1	37.9	35.7	34.3	35.6	36.1	42.7	53.6	56.1	56.1	48.2
E(t)	61.2	81.2	85.2	85.9	93.1	97.8	113.8	77.0	46.4	49.3	37.3	49.6	61.5	81.7	85.4	85.9	93.2	98.2	114.2	77.4

Appendix D (Continued)

Table D11. (Continued)

	2023 641 M	642 J	643 J	644 A	645 S	646 O	647 N	648 D	2024 649 J	650 F	651 M	652 A	653 M	654 J	655 J	656 A	657 S	658 O	659 N	660 D
P(t)	75.7	57.9	48.5	42.1	60.3	105.2	114.1	190.7	222.1	162.6	152.2	104.5	75.6	57.9	48.5	42.1	60.2	104.5	111.7	191.4
PE(t)	78.9	86.1	66.9	92.1	117.4	155.4	161.8	150.3	150.4	156.8	183.5	128.7	79.3	86.4	67.1	92.4	118.2	156.9	163.2	150.9
W(t)	1037.5	1010.7	974.7	948.2	930.0	946.2	949.6	1025.7	1125.2	1144.5	1145.2	1082.1	1036.4	1009.6	973.6	947.1	928.7	944.1	944.7	1021.6
Y(t)	999.4	975.7	943.5	919.4	902.9	917.7	920.7	989.0	1075.4	1091.7	1092.2	1038.4	998.4	974.7	942.4	918.4	901.7	915.7	916.3	985.4
Sw(t)	952.9	926.2	906.1	869.7	841.1	835.4	835.0	903.2	982.0	993.0	977.6	960.7	951.7	925.1	905.0	868.5	839.6	832.9	830.2	899.5
Ro(t)	32.1	29.5	26.4	24.2	22.8	24.1	24.3	31.0	42.0	44.6	44.7	36.9	32.0	29.4	26.3	24.1	22.8	23.9	24.0	30.6
Rg(t)	6.0	5.5	4.9	4.5	4.2	4.5	4.5	5.8	7.8	8.3	8.3	6.8	5.9	5.5	4.9	4.5	4.2	4.4	4.5	5.7
Sg(t)	3883.7	3877.9	3871.6	3864.9	3857.9	3851.2	3844.5	3839.1	3835.8	3833.0	3830.1	3825.9	3820.7	3815.1	3808.9	3802.4	3795.6	3789.0	3782.5	3777.2
Qg(t)	11.3	11.3	11.2	11.2	11.2	11.2	11.2	11.2	11.1	11.1	11.1	11.1	11.1	11.1	11.1	11.0	11.0	11.0	11.0	11.0
Q(t)	43.4	40.8	37.6	35.4	34.0	35.3	35.5	42.1	53.2	55.7	55.8	48.0	43.1	40.5	37.3	35.2	33.8	34.9	34.9	41.5
E(t)	46.5	49.5	37.4	49.7	61.8	82.2	85.7	85.9	93.4	98.7	114.6	77.7	46.7	49.6	37.5	49.9	62.1	82.8	86.0	85.8
	2025 661 J	662 F	663 M	664 A	665 M	666 J	667 J	668 A	669 S	670 O	671 N	672 D	2026 673 J	674 F	675 M	676 A	677 M	678 J	679 J	680 A
P(t)	224.0	162.9	152.9	104.8	75.6	57.9	48.5	42.1	60.1	103.8	109.4	192.0	226.0	163.3	153.5	105.1	75.5	57.9	48.5	42.1
PE(t)	150.9	157.7	184.4	129.4	79.6	86.7	67.4	92.8	118.9	158.3	164.6	151.4	151.4	158.7	185.2	130.0	80.0	87.1	67.7	93.3
W(t)	1123.5	1143.3	1144.4	1081.3	1035.2	1008.5	972.5	946.0	927.5	941.9	939.8	1017.5	1121.9	1142.1	1143.6	1080.5	1034.1	1007.4	971.3	944.9
Y(t)	1073.9	1090.6	1091.5	1037.7	997.4	973.7	941.4	917.4	900.6	913.8	911.8	981.7	1072.6	1089.6	1090.9	1037.0	996.4	972.7	940.4	916.4
Sw(t)	980.4	991.5	976.5	959.7	950.6	924.0	903.9	867.4	838.1	830.4	825.5	895.9	978.8	990.0	975.4	958.6	949.4	922.9	902.7	866.2
Ro(t)	41.8	44.4	44.6	36.8	31.9	29.3	26.2	24.1	22.7	23.7	23.6	30.2	41.6	44.3	44.5	36.7	31.8	29.2	26.1	24.0
Rg(t)	7.8	8.3	8.3	6.8	5.9	5.4	4.9	4.5	4.2	4.4	4.4	5.6	7.7	8.2	8.3	6.8	5.9	5.4	4.8	4.5
Sg(t)	3774.0	3771.3	3768.6	3764.5	3759.5	3754.1	3748.0	3741.6	3735.0	3728.6	3722.2	3717.0	3713.9	3711.4	3708.8	3704.9	3700.0	3694.7	3688.9	3682.6
Qg(t)	11.0	11.0	10.9	10.9	10.9	10.9	10.9	10.9	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.7	10.7	10.7	10.7
Q(t)	52.8	55.4	55.5	47.7	42.8	40.2	37.1	34.9	33.5	34.6	34.4	41.0	52.4	55.0	55.2	47.4	42.5	40.0	36.8	34.7
E(t)	93.6	99.1	115.0	78.0	46.8	49.7	37.6	50.0	62.4	83.4	86.3	85.8	93.7	99.6	115.5	78.4	47.0	49.8	37.7	50.2

Appendix D (Continued)

Table D11. (Continued)

	2026				2027												2028			
	681	682	683	684	685	686	687	688	689	690	691	692	693	694	695	696	697	698	699	700
	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A
P(t)	59.9	103.1	107.1	192.6	228.0	163.7	154.2	105.3	75.4	57.9	48.5	42.2	59.8	102.5	104.8	193.2	230.0	164.0	154.9	105.6
PE(t)	119.7	159.8	166.1	151.9	151.9	159.6	186.1	130.7	80.4	87.4	67.9	93.7	120.5	161.3	167.5	152.5	152.4	160.5	186.9	131.4
W(t)	926.2	939.8	935.0	1013.4	1120.3	1141.0	1142.8	1079.6	1033.0	1006.2	970.2	943.8	924.9	937.7	930.2	1009.4	1118.8	1139.8	1142.1	1078.8
Y(t)	899.4	911.8	907.5	978.1	1071.2	1088.7	1090.2	1036.3	995.5	971.7	939.4	915.4	898.3	909.9	903.1	974.5	1069.9	1087.7	1089.6	1035.6
Sw(t)	836.7	827.9	820.8	892.3	977.3	988.6	974.3	957.6	948.3	921.7	901.6	865.1	835.2	825.4	816.2	888.8	975.8	987.2	973.2	956.5
Ro(t)	22.6	23.6	23.2	29.8	41.4	44.1	44.3	36.6	31.7	29.1	26.0	23.9	22.5	23.4	22.9	29.4	41.2	43.9	44.2	36.5
Rg(t)	4.2	4.4	4.3	5.5	7.7	8.2	8.2	6.8	5.9	5.4	4.8	4.4	4.2	4.4	4.2	5.5	7.7	8.2	8.2	6.8
Sg(t)	3676.2	3669.9	3663.5	3658.5	3655.5	3653.1	3650.8	3647.0	3642.3	3637.1	3631.4	3625.3	3619.0	3612.8	3606.6	3601.6	3598.8	3596.5	3594.3	3590.7
Qg(t)	10.7	10.7	10.6	10.6	10.6	10.6	10.6	10.6	10.6	10.6	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.4	10.4	10.4
Q(t)	33.2	34.2	33.9	40.4	52.0	54.7	55.0	47.2	42.2	39.7	36.5	34.4	33.0	33.9	33.3	39.9	51.7	54.4	54.7	46.9
E(t)	62.8	83.9	86.6	85.8	93.9	100.1	115.9	78.7	47.2	50.0	37.8	50.4	63.1	84.5	86.9	85.7	94.1	100.5	116.4	79.0

	2028								2029											
	701	702	703	704	705	706	707	708	709	710	711	712	713	714	715	716	717	718	719	720
	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
P(t)	75.4	58.0	48.5	42.2	59.7	101.8	102.6	193.9	232.0	164.4	155.6	105.9	75.3	58.0	48.5	42.2	59.6	101.2	100.4	194.5
PE(t)	80.7	87.7	68.2	94.1	121.3	162.9	169.0	153.0	152.9	161.5	187.8	132.1	81.1	88.1	68.5	94.5	122.1	164.5	170.6	153.5
W(t)	1031.9	1005.1	969.1	942.7	923.6	935.5	925.4	1005.3	1117.2	1138.7	1141.3	1078.0	1030.8	1004.0	967.9	941.5	922.4	933.4	920.7	1001.3
Y(t)	994.5	970.7	938.3	914.4	897.1	907.9	898.7	970.9	1068.6	1086.8	1089.0	1034.9	993.5	969.7	937.3	913.4	895.9	906.0	894.4	967.3
Sw(t)	947.1	920.6	900.5	863.9	833.7	822.8	811.5	885.2	974.3	985.7	972.2	955.5	946.0	919.4	899.3	862.7	832.2	820.3	806.9	881.6
Ro(t)	31.6	29.0	25.9	23.8	22.4	23.3	22.5	29.0	41.0	43.8	44.1	36.4	31.4	28.9	25.8	23.7	22.3	23.1	22.2	28.7
Rg(t)	5.9	5.4	4.8	4.4	4.2	4.3	4.2	5.4	7.6	8.1	8.2	6.8	5.8	5.4	4.8	4.4	4.1	4.3	4.1	5.3
Sg(t)	3586.1	3581.1	3575.5	3569.6	3563.4	3557.4	3551.2	3546.3	3543.7	3541.5	3539.4	3535.9	3531.5	3526.6	3521.2	3515.4	3509.3	3503.5	3497.4	3492.6
Qg(t)	10.4	10.4	10.4	10.4	10.4	10.3	10.3	10.3	10.3	10.3	10.3	10.3	10.3	10.2	10.2	10.2	10.2	10.2	10.2	10.1
Q(t)	42.0	39.4	36.3	34.2	32.7	33.6	32.8	39.3	51.3	54.1	54.4	46.7	41.7	39.2	36.0	33.9	32.5	33.3	32.3	38.8
E(t)	47.3	50.1	37.9	50.5	63.4	85.1	87.2	85.7	94.3	101.0	116.8	79.4	47.5	50.2	38.0	50.7	63.7	85.7	87.6	85.7

Appendix D (Continued)

Table D11. (Continued)

	2030												2031							
	721	722	723	724	725	726	727	728	729	730	731	732	733	734	735	736	737	738	739	740
	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A
P(t)	234.1	164.8	156.3	106.1	75.3	58.0	48.5	42.2	59.5	100.5	98.3	195.1	236.1	165.2	157.0	106.4	75.2	58.0	48.5	42.3
PE(t)	153.4	162.5	188.7	132.8	81.5	88.4	68.7	94.9	122.9	166.1	172.1	154.1	153.9	163.5	189.6	133.5	81.9	88.7	69.0	95.3
W(t)	1115.7	1111.7	1095.0	1018.0	961.4	927.2	886.1	855.8	834.6	844.9	831.4	914.7	1030.6	1049.3	1049.8	985.3	935.7	906.0	868.5	840.8
Y(t)	1040.9	1037.7	1024.5	961.8	914.0	884.6	848.8	821.9	803.1	812.2	800.2	873.8	972.3	987.7	988.1	934.4	892.0	866.2	833.2	808.5
Sw(t)	946.9	938.7	911.9	886.1	869.2	837.7	813.5	775.2	744.4	733.1	719.6	794.5	884.2	892.9	879.0	860.5	848.0	820.1	798.5	762.3
Ro(t)	68.3	67.5	64.4	51.3	43.2	38.9	34.1	30.9	28.8	29.8	28.5	37.4	53.3	56.3	56.4	46.5	39.9	36.4	32.2	29.4
Rg(t)	6.5	6.4	6.1	4.9	4.1	3.7	3.2	2.9	2.7	2.8	2.7	3.5	5.1	5.3	5.4	4.4	3.8	3.5	3.1	2.8
Sg(t)	3483.7	3474.9	3465.7	3455.4	3444.3	3432.9	3421.0	3408.9	3396.7	3384.6	3372.5	3361.2	3351.5	3342.2	3332.8	3322.6	3311.8	3300.7	3289.3	3277.7
Qg(t)	15.3	15.3	15.3	15.2	15.2	15.1	15.1	15.0	15.0	14.9	14.9	14.8	14.8	14.7	14.7	14.6	14.6	14.5	14.5	14.4
Q(t)	83.7	82.8	79.6	66.5	58.4	54.0	49.2	45.9	43.8	44.7	43.4	52.2	68.1	71.1	71.1	61.1	54.5	50.9	46.7	43.9
E(t)	94.0	99.0	112.6	75.7	44.8	47.0	35.3	46.8	58.7	79.1	80.6	79.3	88.1	94.8	109.1	73.9	44.0	46.2	34.7	46.2
	2031				2032												2033			
	741	742	743	744	745	746	747	748	749	750	751	752	753	754	755	756	757	758	759	760
	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A
P(t)	59.4	99.9	96.2	195.7	238.2	165.6	157.6	106.7	75.1	58.0	48.5	42.3	59.3	99.2	94.2	196.4	240.3	165.9	158.3	106.9
PE(t)	123.8	167.7	173.7	154.7	154.4	164.5	190.5	134.3	82.3	89.1	69.3	95.8	124.6	169.3	175.3	155.2	154.9	165.5	191.4	135.0
W(t)	821.7	833.1	819.1	904.7	1024.5	1044.8	1046.6	982.8	933.3	903.9	866.6	839.0	819.9	830.6	814.3	900.7	1023.2	1043.9	1046.1	982.2
Y(t)	791.5	801.7	789.2	865.0	967.2	984.0	985.5	932.3	889.9	864.3	831.5	807.0	789.9	799.4	784.8	861.6	966.1	983.2	985.0	931.8
Sw(t)	733.3	722.9	708.9	786.3	879.3	889.0	876.1	858.1	845.8	818.1	796.7	760.6	731.4	720.1	704.4	782.9	878.0	887.8	875.3	857.3
Ro(t)	27.6	28.7	27.4	36.2	52.3	55.6	55.9	46.2	39.6	36.1	32.0	29.2	27.4	28.4	26.9	35.7	52.1	55.4	55.8	46.1
Rg(t)	2.6	2.7	2.6	3.4	5.0	5.3	5.3	4.4	3.8	3.4	3.0	2.8	2.6	2.7	2.6	3.4	4.9	5.3	5.3	4.4
Sg(t)	3265.9	3254.3	3242.6	3231.8	3222.6	3213.7	3204.9	3195.2	3184.9	3174.4	3163.5	3152.4	3141.1	3130.1	3118.9	3108.6	3099.9	3091.5	3083.2	3074.1
Qg(t)	14.4	14.3	14.3	14.2	14.2	14.2	14.1	14.1	14.0	14.0	13.9	13.9	13.8	13.8	13.7	13.7	13.7	13.6	13.6	13.5
Q(t)	42.0	43.0	41.7	50.4	66.5	69.7	70.0	60.2	53.6	50.1	46.0	43.1	41.3	42.2	40.7	49.4	65.8	69.1	69.4	59.6
E(t)	58.2	78.8	80.2	78.8	87.9	95.0	109.3	74.1	44.1	46.2	34.8	46.3	58.5	79.3	80.5	78.7	88.1	95.5	109.8	74.5

Appendix D (Continued)

Table D11. (Continued)

	2033								2034											
	761	762	763	764	765	766	767	768	769	770	771	772	773	774	775	776	777	778	779	780
	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
P(t)	75.1	58.1	48.5	42.3	59.2	98.6	92.2	197.0	242.4	166.3	159.0	107.2	75.0	58.1	48.5	42.3	59.1	97.9	90.3	197.6
PE(t)	82.7	89.4	69.6	96.2	125.5	171.0	176.9	155.8	155.5	166.5	192.3	135.8	83.1	89.8	69.9	96.6	126.4	172.7	178.6	156.4
W(t)	932.3	902.9	865.6	838.0	818.8	828.6	810.0	897.2	1022.2	1043.3	1045.8	981.7	931.5	902.1	864.7	837.2	817.8	826.7	805.8	893.7
Y(t)	889.1	863.5	830.6	806.1	788.9	797.7	780.9	858.5	965.3	982.7	984.7	931.4	888.4	862.8	829.9	805.3	787.9	796.0	777.1	855.4
Sw(t)	844.9	817.1	795.7	759.7	730.1	717.8	700.2	779.8	877.0	886.7	874.5	856.5	844.0	816.2	794.8	758.7	728.8	715.5	696.0	776.7
Ro(t)	39.5	36.0	31.9	29.2	27.3	28.3	26.5	35.3	52.0	55.3	55.7	46.0	39.4	35.9	31.8	29.1	27.2	28.1	26.2	34.9
Rg(t)	3.7	3.4	3.0	2.8	2.6	2.7	2.5	3.4	4.9	5.3	5.3	4.4	3.7	3.4	3.0	2.8	2.6	2.7	2.5	3.3
Sg(t)	3064.3	3054.3	3043.9	3033.3	3022.6	3012.0	3001.3	2991.5	2983.3	2975.4	2967.7	2959.0	2949.7	2940.2	2930.3	2920.2	2910.0	2899.9	2889.6	2880.3
Qg(t)	13.5	13.5	13.4	13.4	13.3	13.3	13.2	13.2	13.1	13.1	13.1	13.0	13.0	13.0	12.9	12.9	12.8	12.8	12.7	12.7
Q(t)	53.0	49.4	45.3	42.5	40.7	41.5	39.8	48.5	65.1	68.4	68.8	59.0	52.4	48.8	44.7	41.9	40.1	40.9	38.9	47.6
E(t)	44.2	46.4	34.9	46.5	58.8	79.9	80.8	78.7	88.3	96.0	110.2	74.9	44.4	46.5	35.0	46.6	59.1	80.5	81.1	78.7

	2035												2036							
	781	782	783	784	785	786	787	788	789	790	791	792	793	794	795	796	797	798	799	800
	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A
P(t)	244.6	166.7	159.7	107.5	75.0	58.1	48.5	42.4	58.9	97.3	88.4	198.3	246.7	167.1	160.4	107.7	74.9	58.1	48.5	42.4
PE(t)	156.0	167.5	193.3	136.5	83.5	90.2	70.2	97.1	127.2	174.5	180.2	156.9	156.5	168.6	194.2	137.3	83.9	90.5	70.4	97.5
W(t)	1021.3	1042.7	1045.5	981.3	930.7	901.2	863.8	836.3	816.7	824.8	801.6	890.2	1020.4	1042.1	1045.2	980.8	929.9	900.3	862.9	835.4
Y(t)	964.5	982.2	984.5	931.0	887.7	862.0	829.1	804.6	787.0	794.3	773.3	852.3	963.8	981.7	984.2	930.6	887.0	861.2	828.3	803.8
Sw(t)	876.0	885.7	873.8	855.7	843.1	815.3	793.9	757.8	727.5	713.2	691.9	773.7	875.0	884.7	873.1	855.0	842.2	814.4	793.0	756.8
Ro(t)	51.8	55.2	55.7	45.9	39.3	35.8	31.7	29.0	27.2	27.9	25.8	34.6	51.7	55.1	55.6	45.9	39.2	35.7	31.6	28.9
Rg(t)	4.9	5.2	5.3	4.4	3.7	3.4	3.0	2.8	2.6	2.6	2.4	3.3	4.9	5.2	5.3	4.4	3.7	3.4	3.0	2.7
Sg(t)	2872.5	2865.1	2857.8	2849.7	2840.9	2831.8	2822.4	2812.7	2803.0	2793.3	2783.5	2774.6	2767.3	2760.4	2753.5	2745.8	2737.4	2728.8	2719.8	2710.6
Qg(t)	12.7	12.6	12.6	12.6	12.5	12.5	12.4	12.4	12.3	12.3	12.3	12.2	12.2	12.2	12.1	12.1	12.1	12.0	12.0	11.9
Q(t)	64.5	67.9	68.3	58.5	51.8	48.3	44.2	41.4	39.5	40.2	38.1	46.8	63.9	67.3	67.8	58.0	51.3	47.7	43.6	40.8
E(t)	88.5	96.5	110.7	75.2	44.6	46.7	35.1	46.8	59.4	81.1	81.4	78.7	88.8	97.0	111.2	75.6	44.8	46.8	35.2	47.0

Appendix D (Continued)

Table D11. (Continued)

	2036				2037												2038			
	801	802	803	804	805	806	807	808	809	810	811	812	813	814	815	816	817	818	819	820
	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A
P(t)	58.8	96.7	86.5	198.9	248.9	167.5	161.1	108.0	74.8	58.2	48.5	42.4	58.7	96.0	84.7	199.6	251.1	167.8	161.9	108.3
PE(t)	128.1	176.3	182.0	157.5	157.1	169.6	195.2	138.0	84.3	90.9	70.7	98.0	129.0	178.1	183.7	158.1	157.6	170.7	196.1	138.8
W(t)	815.6	822.9	797.4	886.7	1019.5	1041.5	1044.9	980.3	929.1	899.5	862.0	834.5	814.6	821.0	793.2	883.2	1018.7	1041.0	1044.6	979.9
Y(t)	786.0	792.6	769.5	849.3	963.1	981.3	984.0	930.2	886.3	860.5	827.5	803.0	785.1	790.8	765.8	846.2	962.4	980.8	983.8	929.8
Sw(t)	726.3	710.9	687.8	770.6	874.1	883.7	872.3	854.2	841.3	813.5	792.1	755.9	725.0	708.5	683.7	767.6	873.2	882.7	871.6	853.5
Ro(t)	27.1	27.7	25.4	34.2	51.6	55.0	55.6	45.8	39.1	35.6	31.6	28.8	27.0	27.5	25.1	33.8	51.4	55.0	55.5	45.7
Rg(t)	2.6	2.6	2.4	3.2	4.9	5.2	5.3	4.3	3.7	3.4	3.0	2.7	2.6	2.6	2.4	3.2	4.9	5.2	5.3	4.3
Sg(t)	2701.3	2692.1	2682.7	2674.1	2667.3	2660.8	2654.4	2647.1	2639.2	2630.9	2622.4	2613.6	2604.7	2595.9	2586.9	2578.7	2572.3	2566.2	2560.2	2553.3
Qg(t)	11.9	11.9	11.8	11.8	11.7	11.7	11.7	11.7	11.6	11.6	11.6	11.5	11.5	11.4	11.4	11.4	11.3	11.3	11.3	11.2
Q(t)	39.0	39.6	37.2	46.0	63.3	66.8	67.3	57.5	50.7	47.2	43.1	40.3	38.4	39.0	36.5	45.2	62.8	66.3	66.8	57.0
E(t)	59.8	81.7	81.7	78.7	89.0	97.5	111.7	76.0	45.0	46.9	35.3	47.1	60.1	82.3	82.1	78.7	89.2	98.1	112.2	76.3

	2038								2039											
	821	822	823	824	825	826	827	828	829	830	831	832	833	834	835	836	837	838	839	840
	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
P(t)	74.8	58.2	48.5	42.4	58.6	95.4	82.9	200.2	272.7	168.7	166.5	109.4	74.6	58.2	48.5	42.6	58.4	94.7	90.3	203.9
PE(t)	84.8	91.3	71.0	98.5	130.0	179.9	185.5	158.7	159.6	171.9	199.7	141.1	86.8	92.2	72.5	100.5	132.9	188.5	191.5	160.9
W(t)	928.2	898.6	861.1	833.6	813.5	819.1	789.1	879.8	1037.2	1054.7	1058.7	989.3	934.1	902.5	863.8	835.3	813.7	817.2	791.3	882.8
Y(t)	885.5	859.7	826.7	802.2	784.1	789.1	762.0	843.2	977.7	992.0	995.3	937.8	890.7	863.1	829.0	803.7	784.3	787.4	764.0	845.8
Sw(t)	840.4	812.6	791.2	754.9	723.6	706.2	679.6	764.5	886.0	892.2	879.9	859.6	844.2	815.3	792.8	755.3	722.5	701.0	678.8	765.9
Ro(t)	39.0	35.5	31.5	28.7	26.9	27.4	24.7	33.4	54.3	57.2	57.9	47.1	39.7	35.9	31.7	28.9	26.9	27.2	24.9	33.7
Rg(t)	3.7	3.4	3.0	2.7	2.5	2.6	2.3	3.2	5.2	5.4	5.5	4.5	3.8	3.4	3.0	2.7	2.6	2.6	2.4	3.2
Sg(t)	2545.8	2538.0	2529.8	2521.4	2512.9	2504.5	2495.8	2488.0	2482.3	2476.8	2471.4	2465.0	2458.0	2450.6	2442.8	2434.8	2426.7	2418.6	2410.4	2403.0
Qg(t)	11.2	11.2	11.1	11.1	11.1	11.0	11.0	11.0	10.9	10.9	10.9	10.9	10.8	10.8	10.8	10.7	10.7	10.7	10.6	10.6
Q(t)	50.2	46.7	42.6	39.8	37.9	38.4	35.7	44.4	65.3	68.1	68.8	57.9	50.5	46.7	42.5	39.6	37.6	37.9	35.5	44.3
E(t)	45.1	47.1	35.5	47.3	60.4	82.9	82.4	78.7	91.7	99.9	115.4	78.2	46.4	47.8	36.3	48.3	61.8	86.5	85.2	79.9

Appendix D (Continued)

Table D11. (Continued)

	2040												2041							
	841	842	843	844	845	846	847	848	849	850	851	852	853	854	855	856	857	858	859	860
	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A
P(t)	275.1	169.1	167.2	109.7	74.5	58.3	48.5	42.6	58.3	94.1	88.4	204.6	275.3	168.4	167.9	109.8	74.4	58.3	48.5	42.6
PE(t)	160.2	173.0	200.7	141.9	87.2	92.6	72.8	101.0	133.9	190.5	193.4	161.5	161.7	175.3	203.0	143.6	87.9	93.2	73.3	101.7
W(t)	1041.0	1057.6	1060.9	990.6	934.7	902.7	863.8	835.2	813.3	815.8	787.3	879.5	1038.3	1054.1	1057.7	987.2	931.1	899.4	860.8	832.4
Y(t)	980.8	994.4	997.1	938.9	891.1	863.3	829.0	803.5	783.9	786.2	760.4	842.9	978.6	991.5	994.5	936.0	888.0	860.4	826.4	801.1
Sw(t)	888.5	893.7	880.9	860.2	844.4	815.3	792.6	755.0	721.7	699.0	674.9	763.0	885.6	889.9	877.4	856.7	841.1	812.4	789.9	752.3
Ro(t)	55.0	57.7	58.3	47.3	39.8	36.0	31.7	28.9	26.8	27.1	24.6	33.4	54.5	57.1	57.7	46.8	39.3	35.6	31.4	28.6
Rg(t)	5.2	5.5	5.5	4.5	3.8	3.4	3.0	2.7	2.5	2.6	2.3	3.2	5.2	5.4	5.5	4.4	3.7	3.4	3.0	2.7
Sg(t)	2397.7	2392.6	2387.6	2381.6	2374.9	2367.9	2360.5	2352.9	2345.1	2337.4	2329.5	2322.4	2317.4	2312.6	2307.9	2302.2	2295.9	2289.2	2282.1	2274.8
Qg(t)	10.6	10.5	10.5	10.5	10.5	10.4	10.4	10.4	10.3	10.3	10.3	10.2	10.2	10.2	10.2	10.1	10.1	10.1	10.1	10.0
Q(t)	65.5	68.3	68.8	57.8	50.2	46.4	42.1	39.2	37.2	37.4	34.8	43.6	64.7	67.3	67.9	56.9	49.5	45.7	41.5	38.6
E(t)	92.3	100.7	116.2	78.7	46.7	48.0	36.4	48.6	62.2	87.2	85.6	80.0	92.9	101.7	117.1	79.4	46.9	48.1	36.5	48.8

	2041				2042												2043			
	861	862	863	864	865	866	867	868	869	870	871	872	873	874	875	876	877	878	879	880
	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A
P(t)	58.2	92.9	78.3	204.9	275.5	167.8	168.5	110.0	74.4	58.3	48.5	42.5	58.1	91.8	69.4	205.2	275.8	167.2	169.2	110.1
PE(t)	135.3	193.4	196.4	163.2	163.2	177.7	205.3	145.3	88.6	93.7	73.7	102.5	136.8	196.5	199.5	165.0	164.8	180.1	207.7	147.1
W(t)	810.5	811.7	772.8	866.8	1027.6	1044.6	1050.2	980.7	925.0	894.1	856.2	828.2	806.5	806.6	758.5	854.4	1017.0	1035.2	1042.6	974.0
Y(t)	781.4	782.5	747.2	831.7	969.7	983.8	988.3	930.5	882.8	855.8	822.3	797.3	777.8	777.9	734.2	820.7	961.0	976.0	982.1	924.8
Sw(t)	718.8	694.4	661.9	752.0	876.8	881.6	870.7	850.6	835.8	807.7	785.7	748.4	714.8	689.0	649.1	741.2	868.0	873.4	863.9	844.6
Ro(t)	26.6	26.7	23.4	32.0	52.8	55.6	56.5	45.8	38.6	35.0	31.0	28.2	26.2	26.2	22.2	30.8	51.2	54.0	55.2	44.9
Rg(t)	2.5	2.5	2.2	3.0	5.0	5.3	5.4	4.4	3.7	3.3	2.9	2.7	2.5	2.5	2.1	2.9	4.9	5.1	5.2	4.3
Sg(t)	2267.3	2259.9	2252.2	2245.4	2240.5	2235.9	2231.5	2226.0	2219.9	2213.5	2206.7	2199.7	2192.5	2185.4	2177.9	2171.2	2166.6	2162.2	2157.9	2152.7
Qg(t)	10.0	10.0	9.9	9.9	9.9	9.8	9.8	9.8	9.8	9.7	9.7	9.7	9.7	9.6	9.6	9.6	9.5	9.5	9.5	9.5
Q(t)	36.6	36.7	33.3	41.9	62.7	65.4	66.3	55.7	48.4	44.7	40.7	37.9	35.9	35.9	31.8	40.3	60.7	63.5	64.7	54.4
E(t)	62.6	88.1	85.3	79.7	92.9	102.2	117.6	79.8	47.0	48.1	36.6	48.9	63.0	88.8	85.0	79.4	92.9	102.7	118.2	80.2

Appendix D (Continued)

Table D11. (Continued)

	2043								2044											
	881	882	883	884	885	886	887	888	889	890	891	892	893	894	895	896	897	898	899	900
	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
P(t)	74.3	58.4	48.5	42.5	58.0	90.7	61.6	205.6	276.0	166.5	169.9	110.2	74.2	58.4	48.5	42.5	57.9	89.6	54.6	205.9
PE(t)	89.3	94.3	74.2	103.3	138.4	199.6	202.6	166.8	166.4	182.5	210.2	148.9	90.1	94.8	74.7	104.1	139.9	202.8	205.9	168.6
W(t)	918.9	888.7	851.4	824.0	802.5	801.4	745.2	842.6	1007.0	1026.2	1035.3	967.5	912.8	883.4	846.7	819.7	798.4	796.3	732.7	831.6
Y(t)	877.4	851.0	818.1	793.5	774.1	773.2	721.9	810.2	952.6	968.6	976.1	919.3	872.2	846.4	813.9	789.7	770.5	768.5	710.5	800.4
Sw(t)	830.4	802.9	781.4	744.5	710.8	683.6	637.1	731.0	859.6	865.4	857.3	838.6	825.0	798.2	777.2	740.5	706.7	678.1	625.7	721.3
Ro(t)	37.9	34.4	30.5	27.8	25.9	25.8	21.2	29.6	49.7	52.6	54.0	44.0	37.1	33.8	30.0	27.4	25.5	25.3	20.3	28.5
Rg(t)	3.6	3.3	2.9	2.6	2.5	2.4	2.0	2.8	4.7	5.0	5.1	4.2	3.5	3.2	2.8	2.6	2.4	2.4	1.9	2.7
Sg(t)	2146.8	2140.7	2134.2	2127.4	2120.5	2113.7	2106.4	2100.0	2095.5	2091.2	2087.2	2082.2	2076.6	2070.7	2064.4	2057.9	2051.3	2044.7	2037.7	2031.4
Qg(t)	9.5	9.4	9.4	9.4	9.3	9.3	9.3	9.2	9.2	9.2	9.2	9.2	9.1	9.1	9.1	9.1	9.0	9.0	9.0	8.9
Q(t)	47.3	43.8	39.9	37.2	35.2	35.1	30.5	38.9	58.9	61.8	63.2	53.2	46.3	42.9	39.1	36.5	34.6	34.3	29.2	37.5
E(t)	47.1	48.1	36.6	49.0	63.4	89.6	84.9	79.2	93.0	103.2	118.8	80.7	47.2	48.1	36.7	49.1	63.7	90.4	84.8	79.1

	2045												2046							
	901	902	903	904	905	906	907	908	909	910	911	912	913	914	915	916	917	918	919	920
	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A
P(t)	276.2	165.9	170.5	110.3	74.1	58.4	48.5	42.5	57.8	88.5	48.4	206.2	276.4	165.3	171.2	110.5	74.1	58.4	48.5	42.5
PE(t)	168.0	185.1	212.7	150.7	90.8	95.4	75.1	104.9	141.5	206.1	209.2	170.5	169.7	187.7	215.3	152.6	91.6	96.0	75.6	105.7
W(t)	997.5	1017.5	1028.1	961.2	906.9	878.1	842.1	815.5	794.4	791.1	721.0	821.2	988.5	1009.1	1021.2	954.9	900.9	872.9	837.4	811.3
Y(t)	944.7	961.4	970.2	913.9	866.9	841.7	809.7	785.9	766.8	763.9	699.7	791.0	937.0	954.4	964.5	908.5	861.8	837.1	805.6	782.1
Sw(t)	851.6	857.6	850.8	832.7	819.7	793.6	773.0	736.6	702.7	672.6	615.0	712.0	843.9	850.0	844.5	826.9	814.4	788.9	768.8	732.7
Ro(t)	48.3	51.2	52.9	43.2	36.4	33.2	29.5	27.0	25.2	24.9	19.4	27.6	47.0	50.0	51.8	42.4	35.8	32.7	29.1	26.7
Rg(t)	4.6	4.9	5.0	4.1	3.5	3.2	2.8	2.6	2.4	2.4	1.8	2.6	4.5	4.7	4.9	4.0	3.4	3.1	2.8	2.5
Sg(t)	2027.1	2023.1	2019.2	2014.4	2009.0	2003.4	1997.4	1991.2	1984.8	1978.5	1971.6	1965.6	1961.4	1957.5	1953.8	1949.3	1944.1	1938.7	1932.9	1927.0
Qg(t)	8.9	8.9	8.9	8.9	8.8	8.8	8.8	8.8	8.7	8.7	8.7	8.7	8.6	8.6	8.6	8.6	8.6	8.5	8.5	8.5
Q(t)	57.2	60.2	61.8	52.1	45.3	42.1	38.3	35.8	33.9	33.6	28.1	36.2	55.6	58.6	60.4	51.0	44.3	41.2	37.6	35.1
E(t)	93.1	103.8	119.4	81.2	47.3	48.1	36.7	49.3	64.1	91.2	84.8	79.0	93.2	104.4	120.0	81.7	47.4	48.2	36.7	49.4

Appendix D (Continued)

Table D11. (Continued)

	2046				2047												2048			
	921	922	923	924	925	926	927	928	929	930	931	932	933	934	935	936	937	938	939	940
	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A
P(t)	57.7	87.4	42.9	206.6	276.7	164.6	171.9	110.6	74.0	58.5	48.5	42.4	57.6	86.3	38.0	206.9	276.9	164.0	172.6	110.7
PE(t)	143.1	209.5	212.7	172.4	171.4	190.4	217.9	154.6	92.4	96.6	76.1	106.6	144.8	213.0	216.2	174.4	173.2	193.1	220.6	156.6
W(t)	790.4	786.0	710.0	811.3	979.8	1001.1	1014.5	948.8	895.1	867.6	832.8	807.1	786.3	780.9	699.6	801.9	971.6	993.2	1007.9	942.7
Y(t)	763.2	759.2	689.6	782.1	929.8	947.6	958.9	903.3	856.6	832.5	801.4	778.3	759.5	754.6	679.9	773.6	922.7	941.1	953.4	898.0
Sw(t)	698.6	667.1	604.8	703.2	836.4	842.6	838.2	821.1	809.2	784.3	764.6	728.7	694.6	661.6	595.0	694.7	829.2	835.3	832.0	815.3
Ro(t)	24.8	24.5	18.7	26.7	45.7	48.8	50.8	41.6	35.1	32.1	28.7	26.3	24.5	24.0	18.0	25.8	44.6	47.6	49.8	40.8
Rg(t)	2.4	2.3	1.8	2.5	4.3	4.6	4.8	3.9	3.3	3.1	2.7	2.5	2.3	2.3	1.7	2.5	4.2	4.5	4.7	3.9
Sg(t)	1920.8	1914.7	1908.1	1902.3	1898.2	1894.5	1891.0	1886.7	1881.7	1876.5	1871.0	1865.2	1859.4	1853.5	1847.1	1841.4	1837.5	1834.0	1830.6	1826.5
Qg(t)	8.5	8.4	8.4	8.4	8.4	8.3	8.3	8.3	8.3	8.3	8.2	8.2	8.2	8.2	8.1	8.1	8.1	8.1	8.1	8.0
Q(t)	33.3	32.9	27.1	35.0	54.1	57.1	59.1	49.9	43.4	40.4	36.9	34.5	32.7	32.2	26.1	33.9	52.7	55.7	57.9	48.8
E(t)	64.5	92.1	84.8	78.9	93.3	105.1	120.7	82.2	47.5	48.2	36.8	49.5	64.9	93.0	85.0	78.9	93.5	105.8	121.4	82.7

	2048								2049											
	941	942	943	944	945	946	947	948	949	950	951	952	953	954	955	956	957	958	959	960
	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
P(t)	73.9	58.5	48.5	42.4	57.5	85.2	33.7	207.2	277.1	163.4	173.3	110.8	73.8	58.5	48.5	42.4	57.4	84.2	29.9	207.5
PE(t)	93.2	97.2	76.6	107.4	146.5	216.6	219.9	176.4	174.9	196.0	223.4	158.6	94.0	97.8	77.1	108.3	148.3	220.4	223.7	178.4
W(t)	889.2	862.4	828.2	802.8	782.3	775.7	689.7	792.9	963.6	985.6	1001.4	936.7	883.4	857.2	823.5	798.6	778.2	770.5	680.3	784.2
Y(t)	851.5	827.8	797.3	774.5	755.8	749.9	670.8	765.4	915.9	934.6	947.9	892.9	846.4	823.2	793.1	770.7	752.1	745.2	662.0	757.6
Sw(t)	803.9	779.6	760.4	724.8	690.5	656.0	585.6	686.5	822.2	828.1	825.8	809.6	798.7	775.0	756.2	720.8	686.4	650.4	576.6	678.6
Ro(t)	34.5	31.6	28.2	25.9	24.1	23.6	17.3	25.0	43.5	46.5	48.8	40.0	33.8	31.1	27.8	25.5	23.8	23.2	16.7	24.3
Rg(t)	3.3	3.0	2.7	2.5	2.3	2.2	1.6	2.4	4.1	4.4	4.6	3.8	3.2	2.9	2.6	2.4	2.3	2.2	1.6	2.3
Sg(t)	1821.7	1816.7	1811.4	1805.9	1800.3	1794.6	1788.4	1782.9	1779.2	1775.8	1772.6	1768.6	1764.1	1759.3	1754.2	1748.9	1743.5	1738.0	1732.0	1726.7
Qg(t)	8.0	8.0	8.0	8.0	7.9	7.9	7.9	7.9	7.8	7.8	7.8	7.8	7.8	7.7	7.7	7.7	7.7	7.7	7.6	7.6
Q(t)	42.5	39.6	36.2	33.9	32.1	31.5	25.2	32.9	51.4	54.4	56.6	47.8	41.6	38.8	35.5	33.2	31.5	30.8	24.3	31.9
E(t)	47.6	48.2	36.8	49.7	65.4	93.8	85.1	79.0	93.7	106.5	122.1	83.3	47.7	48.2	36.9	49.8	65.8	94.8	85.4	79.0

Appendix D (Continued)

Table D11. (Continued)

	2050 961 J	962 F	963 M	964 A	965 M	966 J	967 J	968 A	969 S	970 O	971 N	972 D
P(t)	277.3	162.8	173.9	111.0	73.8	58.6	48.5	42.4	57.3	83.1	26.5	207.9
PE(t)	176.8	198.9	226.2	160.7	94.8	98.4	77.7	109.2	150.1	224.2	227.5	180.6
W(t)	955.9	978.1	995.0	930.7	877.6	852.0	818.9	794.4	774.1	765.4	671.2	775.8
Y(t)	909.4	928.3	942.6	887.7	841.3	818.6	788.9	766.8	748.4	740.4	653.6	750.0
Sw(t)	815.4	821.1	819.7	803.9	793.5	770.4	752.0	716.8	682.2	644.7	567.9	670.9
Ro(t)	42.5	45.5	47.9	39.3	33.2	30.5	27.4	25.2	23.5	22.8	16.1	23.6
Rg(t)	4.0	4.3	4.5	3.7	3.2	2.9	2.6	2.4	2.2	2.2	1.5	2.2
Sg(t)	1723.1	1719.9	1716.9	1713.1	1708.7	1704.1	1699.2	1694.1	1688.9	1683.6	1677.8	1672.7
Qg(t)	7.6	7.6	7.6	7.5	7.5	7.5	7.5	7.5	7.4	7.4	7.4	7.4
Q(t)	50.1	53.1	55.5	46.8	40.7	38.0	34.8	32.6	30.9	30.2	23.5	31.0
E(t)	94.0	107.2	122.8	83.8	47.8	48.2	36.9	50.0	66.2	95.7	85.6	79.1

Appendix D (Continued)

Table D12. Water balance output values – moderate growth and A1B scenarios (2010-2050) .

	2010												2011							
	481	482	483	484	485	486	487	488	489	490	491	492	493	494	495	496	497	498	499	500
	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A
P(t)	292.8	199.5	119.7	100.3	83.1	7.1	55.2	46.8	74.6	113.4	154.9	188.8	198.1	157.8	143.8	101.2	76.4	57.6	48.5	41.8
PE(t)	144.0	145.2	172.7	120.1	74.6	82.2	63.8	87.3	108.4	138.6	145.4	144.0	144.4	146.2	173.4	120.3	75.0	82.2	64.0	87.7
W(t)	1395.0	1432.9	1380.1	1301.9	1260.7	1182.1	1157.3	1139.0	1135.5	1158.2	1200.5	1265.9	1330.2	1307.4	1276.1	1192.8	1139.5	1106.4	1065.2	1034.5
Y(t)	1343.1	1373.4	1330.8	1264.3	1228.1	1157.0	1134.2	1117.2	1114.0	1135.0	1173.8	1232.7	1253.8	1236.2	1211.4	1142.8	1097.2	1068.2	1031.6	1004.0
Sw(t)	1233.4	1260.4	1201.6	1177.6	1175.0	1102.1	1092.2	1061.0	1044.8	1045.6	1077.1	1132.1	1149.6	1132.3	1091.6	1063.1	1048.9	1016.7	992.7	952.5
Ro(t)	40.2	46.0	38.1	29.0	25.2	19.4	17.9	16.8	16.7	17.9	20.6	25.7	62.9	58.6	53.2	41.2	34.9	31.5	27.7	25.1
Rg(t)	11.8	13.5	11.2	8.5	7.4	5.7	5.2	4.9	4.9	5.3	6.0	7.5	13.5	12.6	11.4	8.8	7.5	6.8	5.9	5.4
Sg(t)	4806.6	4813.3	4817.8	4819.5	4820.1	4819.0	4817.5	4815.7	4813.8	4812.3	4811.6	4812.4	4818.6	4823.9	4828.1	4829.7	4829.9	4829.4	4828.1	4826.2
Qg(t)	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3
Q(t)	46.9	52.8	44.9	35.8	32.0	26.2	24.7	23.6	23.4	24.7	27.4	32.4	70.2	65.9	60.5	48.4	42.2	38.7	34.9	32.4
E(t)	109.7	113.0	129.2	86.7	53.0	54.9	42.0	56.2	69.2	89.4	96.7	100.6	104.1	103.9	119.8	79.7	48.3	51.5	38.9	51.5

	2011				2012												2013			
	501	502	503	504	505	506	507	508	509	510	511	512	513	514	515	516	517	518	519	520
	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A
P(t)	61.6	113.6	147.4	183.5	198.6	157.0	144.7	101.3	76.4	57.6	48.5	41.7	61.6	112.5	144.8	184.0	199.1	156.2	145.7	101.5
PE(t)	109.0	139.9	146.5	144.6	144.8	147.2	174.2	120.5	75.4	82.3	64.2	88.2	109.6	141.1	147.6	145.3	145.3	148.2	174.9	120.7
W(t)	1014.1	1036.7	1072.4	1134.1	1200.2	1210.3	1204.4	1139.4	1096.8	1070.5	1034.9	1008.1	991.1	1015.6	1051.5	1116.8	1186.4	1198.6	1195.7	1132.5
Y(t)	985.6	1006.0	1038.0	1092.5	1149.0	1157.6	1152.6	1097.0	1059.7	1036.3	1004.3	980.0	964.5	986.9	1019.3	1077.3	1137.4	1147.7	1145.3	1091.0
Sw(t)	923.1	925.0	950.6	1001.6	1053.3	1059.6	1038.1	1020.5	1012.9	986.4	966.3	929.5	903.1	906.7	932.9	987.3	1042.4	1050.0	1031.0	1014.8
Ro(t)	23.5	25.3	28.3	34.3	42.1	43.5	42.7	34.9	30.5	28.1	25.1	23.1	21.9	23.6	26.5	32.5	40.4	41.9	41.5	34.1
Rg(t)	5.1	5.4	6.1	7.4	9.0	9.3	9.2	7.5	6.6	6.0	5.4	5.0	4.7	5.1	5.7	7.0	8.7	9.0	8.9	7.3
Sg(t)	4824.0	4822.1	4821.0	4821.1	4822.9	4824.9	4826.8	4827.0	4826.3	4825.1	4823.2	4820.9	4818.4	4816.2	4814.6	4814.4	4815.8	4817.5	4819.2	4819.3
Qg(t)	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.2	7.2	7.2	7.2	7.2	7.3	7.3
Q(t)	30.8	32.5	35.5	41.6	49.4	50.7	49.9	42.1	37.8	35.4	32.4	30.3	29.1	30.9	33.7	39.8	47.6	49.2	48.8	41.4
E(t)	62.5	81.0	87.4	90.9	95.7	97.9	114.5	76.6	46.9	50.0	38.0	50.5	61.4	80.2	86.5	90.0	95.0	97.7	114.2	76.3

Appendix D (Continued)

Table D12. (Continued)

	2013 521 M	522 J	523 J	524 A	525 S	526 O	527 N	528 D	2014 529 J	530 F	531 M	532 A	533 M	534 J	535 J	536 A	537 S	538 O	539 N	540 D
P(t)	76.3	57.7	48.5	41.7	61.5	111.4	142.2	184.4	199.6	155.5	146.7	101.6	76.3	57.7	48.5	41.7	61.5	110.4	139.6	184.9
PE(t)	75.7	82.3	64.4	88.6	110.2	142.3	148.7	146.0	145.7	149.2	175.7	120.9	76.1	82.4	64.6	89.1	110.9	143.6	149.9	146.7
W(t)	1091.1	1065.4	1030.5	1004.2	987.4	1011.0	1044.4	1110.8	1181.7	1193.9	1192.4	1129.6	1088.6	1063.1	1028.6	1002.3	985.5	1008.0	1038.6	1105.8
Y(t)	1054.7	1031.8	1000.4	976.5	961.2	982.7	1012.9	1072.1	1133.4	1143.7	1142.4	1088.5	1052.5	1029.8	998.6	974.8	959.4	979.9	1007.7	1067.7
Sw(t)	1007.8	982.0	962.5	925.9	899.6	902.2	926.4	982.1	1038.4	1045.7	1028.0	1012.3	1005.4	980.1	960.6	924.0	897.6	899.0	921.0	977.7
Ro(t)	30.0	27.7	24.8	22.8	21.6	23.3	25.9	31.9	39.8	41.3	41.1	33.8	29.8	27.5	24.6	22.7	21.5	23.1	25.4	31.4
Rg(t)	6.4	5.9	5.3	4.9	4.6	5.0	5.6	6.8	8.5	8.9	8.8	7.3	6.4	5.9	5.3	4.9	4.6	5.0	5.5	6.7
Sg(t)	4818.5	4817.2	4815.2	4812.9	4810.3	4808.1	4806.4	4806.0	4807.3	4808.9	4810.5	4810.5	4809.7	4808.3	4806.4	4804.0	4801.4	4799.1	4797.4	4796.9
Qg(t)	7.3	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2
Q(t)	37.2	34.9	32.0	30.0	28.8	30.5	33.1	39.1	47.0	48.5	48.3	41.1	37.0	34.7	31.9	29.9	28.7	30.3	32.6	38.6
E(t)	46.9	49.8	38.0	50.6	61.6	80.5	86.5	90.0	94.9	98.0	114.4	76.2	47.0	49.7	38.0	50.8	61.8	81.0	86.7	90.0

	2015 541 J	542 F	543 M	544 A	545 M	546 J	547 J	548 A	549 S	550 O	551 N	552 D	2016 553 J	554 F	555 M	556 A	557 M	558 J	559 J	560 A
P(t)	200.1	154.7	147.7	101.7	76.3	57.7	48.5	41.7	61.4	109.3	137.1	185.3	200.6	153.9	148.7	101.9	76.2	57.8	48.5	41.6
PE(t)	146.1	150.3	176.5	121.0	76.5	82.4	64.8	89.5	111.5	144.9	151.1	147.4	146.6	151.3	177.3	121.2	76.9	82.4	65.1	90.0
W(t)	1177.8	1189.8	1189.6	1127.1	1086.5	1061.1	1026.8	1000.6	983.7	1005.0	1032.9	1101.0	1174.0	1185.8	1186.8	1124.7	1084.3	1059.1	1025.1	999.0
Y(t)	1130.1	1140.3	1140.1	1086.4	1050.6	1027.9	997.1	973.3	957.8	977.3	1002.6	1063.4	1126.8	1136.9	1137.7	1084.2	1048.6	1026.1	995.5	971.7
Sw(t)	1035.1	1041.9	1025.4	1010.2	1003.4	978.3	959.0	922.3	895.7	895.8	915.7	973.4	1031.9	1038.1	1022.8	1008.1	1001.3	976.5	957.3	920.6
Ro(t)	39.3	40.8	40.7	33.6	29.6	27.3	24.5	22.5	21.3	22.9	25.0	30.9	38.8	40.3	40.4	33.3	29.4	27.1	24.4	22.4
Rg(t)	8.4	8.8	8.7	7.2	6.3	5.9	5.3	4.8	4.6	4.9	5.4	6.6	8.3	8.6	8.7	7.1	6.3	5.8	5.2	4.8
Sg(t)	4798.1	4799.7	4801.2	4801.2	4800.3	4798.9	4797.0	4794.6	4792.0	4789.7	4787.8	4787.2	4788.4	4789.8	4791.3	4791.2	4790.3	4788.9	4787.0	4784.6
Qg(t)	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2
Q(t)	46.5	48.0	48.0	40.8	36.8	34.5	31.7	29.8	28.6	30.1	32.2	38.1	46.0	47.5	47.6	40.5	36.6	34.3	31.6	29.6
E(t)	94.9	98.4	114.7	76.2	47.2	49.6	38.1	50.9	62.0	81.4	86.9	90.1	94.9	98.8	114.9	76.1	47.3	49.6	38.1	51.1

Appendix D (Continued)

Table D12. (Continued)

	2016				2017												2018			
	561	562	563	564	565	566	567	568	569	570	571	572	573	574	575	576	577	578	579	580
	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A
P(t)	61.3	108.2	134.7	185.8	201.2	153.1	149.7	102.0	76.2	57.8	48.5	41.6	61.3	107.2	132.3	186.3	201.7	152.4	150.7	102.2
PE(t)	112.1	146.2	152.2	148.1	147.0	152.4	178.1	121.4	77.3	82.5	65.3	90.5	112.8	147.6	153.5	148.8	147.5	153.5	178.9	121.6
W(t)	981.9	1002.1	1027.3	1096.2	1170.2	1181.8	1184.0	1122.2	1082.1	1057.0	1023.3	997.3	980.2	999.2	1021.8	1091.4	1166.4	1177.8	1181.2	1119.7
Y(t)	956.2	974.6	997.5	1059.2	1123.6	1133.5	1135.3	1082.0	1046.7	1024.3	993.9	970.2	954.5	971.9	992.5	1054.9	1120.4	1130.1	1133.0	1079.9
Sw(t)	893.9	892.7	910.4	969.0	1028.7	1034.3	1020.2	1006.0	999.2	974.8	955.7	918.9	892.0	889.5	905.1	964.7	1025.4	1030.5	1017.5	1003.8
Ro(t)	21.2	22.6	24.5	30.5	38.4	39.8	40.1	33.1	29.2	27.0	24.2	22.3	21.1	22.4	24.1	30.0	37.9	39.3	39.7	32.8
Rg(t)	4.6	4.9	5.3	6.5	8.2	8.5	8.6	7.1	6.3	5.8	5.2	4.8	4.5	4.8	5.2	6.4	8.1	8.4	8.5	7.0
Sg(t)	4781.9	4779.6	4777.7	4777.0	4778.1	4779.4	4780.8	4780.7	4779.8	4778.4	4776.4	4774.0	4771.4	4769.0	4767.0	4766.3	4767.2	4768.5	4769.8	4769.7
Qg(t)	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2
Q(t)	28.4	29.8	31.7	37.7	45.6	47.0	47.2	40.2	36.4	34.1	31.4	29.5	28.3	29.6	31.3	37.2	45.1	46.5	46.9	40.0
E(t)	62.3	81.9	87.2	90.1	94.9	99.1	115.2	76.1	47.5	49.5	38.2	51.3	62.5	82.4	87.4	90.2	94.9	99.5	115.4	76.0

	2018								2019											
	581	582	583	584	585	586	587	588	589	590	591	592	593	594	595	596	597	598	599	600
	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
P(t)	76.1	57.8	48.5	41.6	61.2	106.1	129.9	186.7	202.2	151.6	151.7	102.3	76.1	57.9	48.5	41.6	61.2	105.1	127.6	187.2
PE(t)	77.8	82.5	65.5	90.9	113.4	148.9	154.7	149.5	147.9	154.6	179.8	121.8	78.2	82.6	65.7	91.4	114.1	150.3	155.9	150.2
W(t)	1080.0	1055.0	1021.5	995.6	978.4	996.2	1016.2	1086.6	1162.7	1173.8	1178.4	1117.2	1077.8	1052.9	1019.7	993.9	976.6	993.3	1010.7	1081.8
Y(t)	1044.8	1022.4	992.3	968.6	952.9	969.3	987.5	1050.7	1117.1	1126.7	1130.6	1077.7	1042.9	1020.6	990.7	967.1	951.2	966.6	982.4	1046.4
Sw(t)	997.1	973.0	954.0	917.2	890.1	886.3	899.9	960.5	1022.2	1026.8	1014.9	1001.7	995.0	971.2	952.3	915.4	888.2	883.1	894.6	956.2
Ro(t)	29.0	26.8	24.1	22.2	21.0	22.2	23.7	29.6	37.5	38.8	39.4	32.5	28.8	26.6	24.0	22.1	20.9	22.0	23.3	29.1
Rg(t)	6.2	5.7	5.2	4.8	4.5	4.8	5.1	6.3	8.0	8.3	8.4	7.0	6.2	5.7	5.1	4.7	4.5	4.7	5.0	6.3
Sg(t)	4768.7	4767.3	4765.3	4762.9	4760.3	4757.9	4755.8	4755.0	4755.9	4757.0	4758.3	4758.2	4757.2	4755.7	4753.7	4751.3	4748.6	4746.2	4744.1	4743.2
Qg(t)	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.1	7.1	7.1	7.1	7.1
Q(t)	36.1	34.0	31.3	29.3	28.1	29.4	30.8	36.7	44.6	46.0	46.5	39.7	35.9	33.8	31.1	29.2	28.0	29.2	30.4	36.3
E(t)	47.7	49.4	38.3	51.5	62.7	82.9	87.6	90.2	95.0	99.9	115.7	76.0	47.8	49.4	38.3	51.7	63.0	83.4	87.8	90.3

Appendix D (Continued)

Table D12. (Continued)

	2020 601	602	603	604	605	606	607	608	609	610	611	612	2021 613	614	615	616	617	618	619	620
	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A
P(t)	202.7	150.9	152.7	102.5	76.1	57.9	48.5	41.5	61.1	104.1	125.3	187.6	203.2	150.1	153.7	102.6	76.0	57.9	48.5	41.5
PE(t)	148.4	155.7	180.6	121.9	78.6	82.6	66.0	91.9	114.8	151.7	157.2	150.9	148.8	156.9	181.4	122.1	79.0	82.6	66.2	92.4
W(t)	1158.9	1169.8	1175.6	1114.7	1075.6	1050.8	1018.0	992.2	974.8	990.4	1005.2	1077.1	1155.1	1165.8	1172.8	1112.2	1073.4	1048.7	1016.2	990.4
Y(t)	1113.9	1123.2	1128.2	1075.5	1040.9	1018.7	989.0	965.5	949.6	963.9	977.4	1042.2	1110.6	1119.8	1125.8	1073.3	1039.0	1016.8	987.4	963.9
Sw(t)	1018.9	1022.9	1012.3	999.6	992.9	969.4	950.6	913.7	886.3	879.9	889.4	951.9	1015.7	1019.1	1009.6	997.4	990.8	967.6	948.9	911.9
Ro(t)	37.1	38.3	39.0	32.3	28.6	26.4	23.8	21.9	20.7	21.8	22.9	28.7	36.6	37.9	38.7	32.0	28.4	26.3	23.7	21.8
Rg(t)	8.0	8.2	8.4	6.9	6.1	5.7	5.1	4.7	4.5	4.7	4.9	6.2	7.9	8.1	8.3	6.9	6.1	5.6	5.1	4.7
Sg(t)	4744.0	4745.1	4746.3	4746.1	4745.1	4743.6	4741.6	4739.2	4736.5	4734.1	4731.9	4730.9	4731.7	4732.7	4733.8	4733.6	4732.6	4731.1	4729.1	4726.6
Qg(t)	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1
Q(t)	44.2	45.5	46.2	39.4	35.7	33.6	31.0	29.1	27.9	28.9	30.0	35.8	43.7	45.0	45.8	39.2	35.5	33.4	30.8	28.9
E(t)	95.0	100.3	116.0	75.9	48.0	49.3	38.4	51.8	63.2	83.9	88.0	90.3	95.0	100.7	116.2	75.9	48.2	49.2	38.5	52.0

	2021 621	622	623	624	2022 625	626	627	628	629	630	631	632	633	634	635	636	2023 637	638	639	640
	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A
P(t)	61.0	103.0	123.0	188.1	203.8	149.4	154.8	102.7	76.0	58.0	48.5	41.5	61.0	102.0	120.8	188.6	204.3	148.6	155.8	102.9
PE(t)	115.5	153.2	158.5	151.7	149.3	158.0	182.3	122.3	79.5	82.7	66.4	92.9	116.1	154.6	159.8	152.4	149.8	159.2	183.2	122.5
W(t)	972.9	987.4	999.8	1072.3	1151.4	1161.8	1170.0	1109.7	1071.2	1046.6	1014.3	988.7	971.1	984.5	994.3	1067.6	1147.6	1157.8	1167.2	1107.2
Y(t)	947.9	961.2	972.5	1038.0	1107.4	1116.4	1123.5	1071.1	1037.0	1015.0	985.7	962.3	946.2	958.5	967.5	1033.7	1104.2	1112.9	1121.1	1068.9
Sw(t)	884.4	876.7	884.2	947.6	1012.4	1015.3	1007.0	995.2	988.7	965.8	947.2	910.1	882.4	873.5	879.0	943.3	1009.2	1011.5	1004.3	993.1
Ro(t)	20.6	21.6	22.5	28.3	36.2	37.4	38.4	31.8	28.2	26.1	23.5	21.7	20.5	21.4	22.1	27.9	35.8	36.9	38.0	31.5
Rg(t)	4.4	4.6	4.8	6.1	7.8	8.0	8.2	6.8	6.0	5.6	5.1	4.7	4.4	4.6	4.7	6.0	7.7	7.9	8.2	6.8
Sg(t)	4723.9	4721.5	4719.2	4718.2	4718.8	4719.8	4720.9	4720.6	4719.6	4718.1	4716.0	4713.6	4710.9	4708.4	4706.1	4705.0	4705.6	4706.4	4707.5	4707.2
Qg(t)	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1
Q(t)	27.7	28.7	29.6	35.4	43.3	44.5	45.5	38.9	35.3	33.2	30.6	28.8	27.6	28.5	29.2	34.9	42.9	44.0	45.1	38.6
E(t)	63.5	84.5	88.3	90.4	95.0	101.1	116.5	75.9	48.3	49.2	38.5	52.2	63.7	85.0	88.5	90.4	95.0	101.5	116.8	75.8

Appendix D (Continued)

Table D12. (Continued)

	2023								2024											
	641	642	643	644	645	646	647	648	649	650	651	652	653	654	655	656	657	658	659	660
	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
P(t)	76.0	58.0	48.5	41.5	60.9	101.0	118.7	189.1	204.8	147.9	156.8	103.0	75.9	58.0	48.5	41.4	60.8	100.1	116.6	189.5
PE(t)	79.9	82.7	66.6	93.4	116.8	156.1	161.1	153.2	150.2	160.4	184.0	122.7	80.3	82.7	66.9	93.9	117.6	157.6	162.4	154.0
W(t)	1069.0	1044.5	1012.5	986.9	969.2	981.5	988.9	1062.9	1143.9	1153.8	1164.4	1104.7	1066.8	1042.4	1010.7	985.2	967.4	978.6	983.6	1058.2
Y(t)	1035.0	1013.1	984.1	960.7	944.5	955.8	962.6	1029.5	1100.9	1109.5	1118.7	1066.6	1033.0	1011.2	982.4	959.1	942.8	953.1	957.6	1025.3
Sw(t)	986.5	964.0	945.5	908.3	880.5	870.3	873.8	939.0	1005.9	1007.6	1001.6	990.9	984.4	962.1	943.7	906.5	878.5	867.0	868.6	934.8
Ro(t)	28.0	25.9	23.4	21.6	20.4	21.2	21.7	27.5	35.4	36.5	37.7	31.3	27.8	25.7	23.3	21.5	20.3	21.0	21.3	27.0
Rg(t)	6.0	5.6	5.0	4.6	4.4	4.6	4.7	5.9	7.6	7.8	8.1	6.7	6.0	5.5	5.0	4.6	4.3	4.5	4.6	5.8
Sg(t)	4706.1	4704.6	4702.5	4700.1	4697.4	4694.9	4692.5	4691.3	4691.8	4692.6	4693.6	4693.3	4692.2	4690.7	4688.6	4686.1	4683.5	4680.9	4678.5	4677.2
Qg(t)	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.0	7.0	7.0	7.0
Q(t)	35.1	33.0	30.5	28.6	27.4	28.3	28.8	34.5	42.4	43.5	44.8	38.4	34.9	32.8	30.3	28.5	27.3	28.0	28.4	34.1
E(t)	48.5	49.1	38.6	52.4	64.0	85.5	88.8	90.5	95.0	101.9	117.0	75.8	48.7	49.0	38.7	52.6	64.3	86.1	89.0	90.5

	2025												2026							
	661	662	663	664	665	666	667	668	669	670	671	672	673	674	675	676	677	678	679	680
	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A
P(t)	205.4	147.1	157.9	103.2	75.9	58.1	48.5	41.4	60.8	99.1	114.5	190.0	205.9	146.4	159.0	103.3	75.8	58.1	48.5	41.4
PE(t)	150.7	161.6	184.9	122.9	80.8	82.8	67.1	94.4	118.3	159.1	163.8	154.7	151.2	162.9	185.8	123.1	81.2	82.8	67.4	95.0
W(t)	1140.1	1149.8	1161.6	1102.1	1064.6	1040.3	1008.8	983.4	965.5	975.6	978.2	1053.5	1136.4	1145.8	1158.8	1099.6	1062.3	1038.1	1007.0	981.6
Y(t)	1097.7	1106.1	1116.2	1064.4	1031.0	1009.2	980.7	957.5	941.0	950.3	952.7	1021.1	1094.4	1102.6	1113.8	1062.1	1029.0	1007.3	979.0	955.9
Sw(t)	1002.7	1003.7	998.9	988.7	982.2	960.3	942.0	904.7	876.5	863.7	863.5	930.5	999.4	999.9	996.2	986.5	980.0	958.4	940.2	902.9
Ro(t)	35.0	36.0	37.4	31.0	27.6	25.6	23.1	21.3	20.1	20.8	21.0	26.7	34.5	35.6	37.0	30.8	27.4	25.4	23.0	21.2
Rg(t)	7.5	7.7	8.0	6.7	5.9	5.5	5.0	4.6	4.3	4.5	4.5	5.7	7.4	7.6	8.0	6.6	5.9	5.5	4.9	4.6
Sg(t)	4677.7	4678.4	4679.4	4679.0	4677.9	4676.3	4674.2	4671.8	4669.1	4666.5	4664.0	4662.7	4663.1	4663.7	4664.7	4664.3	4663.1	4661.6	4659.5	4657.0
Qg(t)	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
Q(t)	42.0	43.1	44.4	38.1	34.6	32.6	30.2	28.4	27.2	27.8	28.0	33.7	41.6	42.6	44.1	37.8	34.4	32.4	30.0	28.2
E(t)	95.0	102.3	117.3	75.7	48.8	48.9	38.7	52.8	64.5	86.6	89.3	90.6	95.0	102.7	117.6	75.7	49.0	48.9	38.8	53.0

Appendix D (Continued)

Table D12. (Continued)

	2026				2027												2028			
	681	682	683	684	685	686	687	688	689	690	691	692	693	694	695	696	697	698	699	700
	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A
P(t)	60.7	98.1	112.4	190.5	206.4	145.7	160.0	103.5	75.8	58.1	48.6	41.4	60.7	97.2	110.4	190.9	206.9	144.9	161.1	103.6
PE(t)	119.0	160.7	165.2	155.5	151.7	164.1	186.7	123.3	81.7	82.8	67.6	95.5	119.7	162.3	166.6	156.3	152.2	165.4	187.6	123.4
W(t)	963.6	972.6	972.9	1048.8	1132.6	1141.8	1156.0	1097.0	1060.1	1036.0	1005.1	979.8	961.7	969.7	967.6	1044.1	1128.9	1137.8	1153.2	1094.4
Y(t)	939.3	947.6	947.8	1016.9	1091.1	1099.1	1111.4	1059.9	1027.0	1005.4	977.3	954.2	937.6	944.9	942.9	1012.7	1087.9	1095.7	1109.0	1057.6
Sw(t)	874.5	860.4	858.3	926.2	996.1	996.0	993.5	984.3	977.8	956.6	938.5	901.0	872.5	857.1	853.2	921.9	992.9	992.1	990.8	982.0
Ro(t)	20.0	20.6	20.6	26.3	34.1	35.1	36.7	30.6	27.2	25.2	22.9	21.1	19.9	20.4	20.3	25.9	33.8	34.7	36.4	30.3
Rg(t)	4.3	4.4	4.4	5.6	7.3	7.5	7.9	6.6	5.8	5.4	4.9	4.5	4.3	4.4	4.4	5.6	7.2	7.4	7.8	6.5
Sg(t)	4654.3	4651.8	4649.2	4647.8	4648.2	4648.7	4649.6	4649.2	4648.0	4646.4	4644.3	4641.9	4639.2	4636.6	4634.0	4632.5	4632.8	4633.3	4634.1	4633.7
Qg(t)	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
Q(t)	27.0	27.6	27.6	33.3	41.1	42.1	43.7	37.6	34.2	32.2	29.9	28.1	26.9	27.4	27.2	32.8	40.7	41.7	43.4	37.3
E(t)	64.8	87.2	89.5	90.7	95.0	103.1	117.9	75.6	49.2	48.8	38.9	53.2	65.0	87.7	89.8	90.7	95.0	103.6	118.2	75.6

	2028								2029											
	701	702	703	704	705	706	707	708	709	710	711	712	713	714	715	716	717	718	719	720
	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
P(t)	75.8	58.2	48.6	41.3	60.6	96.2	108.4	191.4	207.5	144.2	162.2	103.8	75.7	58.2	48.6	41.3	60.5	95.3	106.5	191.9
PE(t)	82.2	82.9	67.8	96.0	120.5	163.9	168.0	157.1	152.7	166.7	188.5	123.6	82.6	82.9	68.1	96.6	121.2	165.5	169.5	157.9
W(t)	1057.8	1033.8	1003.2	978.0	959.8	966.7	962.3	1039.4	1125.1	1133.8	1150.4	1091.9	1055.5	1031.6	1001.4	976.2	957.9	963.7	957.0	1034.8
Y(t)	1025.0	1003.4	975.6	952.6	935.8	942.1	938.1	1008.5	1084.6	1092.2	1106.5	1055.3	1023.0	1001.4	973.9	950.9	934.0	939.4	933.2	1004.3
Sw(t)	975.6	954.7	936.7	899.2	870.5	853.8	848.0	917.7	989.6	988.2	988.1	979.8	973.4	952.8	934.9	897.3	868.4	850.5	842.9	913.4
Ro(t)	27.0	25.0	22.7	21.0	19.8	20.2	19.9	25.5	33.4	34.3	36.1	30.1	26.8	24.9	22.6	20.8	19.6	20.0	19.6	25.1
Rg(t)	5.8	5.4	4.9	4.5	4.2	4.3	4.3	5.5	7.2	7.4	7.7	6.5	5.8	5.3	4.8	4.5	4.2	4.3	4.2	5.4
Sg(t)	4632.5	4630.9	4628.8	4626.3	4623.6	4621.0	4618.3	4616.9	4617.1	4617.5	4618.3	4617.8	4616.6	4615.0	4612.9	4610.4	4607.7	4605.1	4602.4	4600.8
Qg(t)	7.0	7.0	7.0	7.0	7.0	7.0	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9
Q(t)	34.0	32.0	29.7	27.9	26.7	27.2	26.9	32.4	40.3	41.2	43.0	37.0	33.8	31.8	29.5	27.8	26.6	26.9	26.5	32.0
E(t)	49.4	48.7	38.9	53.4	65.3	88.3	90.0	90.8	95.0	104.0	118.4	75.5	49.5	48.6	39.0	53.6	65.6	88.9	90.3	90.9

Appendix D (Continued)

Table D12. (Continued)

	2030 721 J	722 F	723 M	724 A	725 M	726 J	727 J	728 A	729 S	730 O	731 N	732 D	2031 733 J	734 F	735 M	736 A	737 M	738 J	739 J	740 A
P(t)	208.0	143.5	163.3	103.9	75.7	58.2	48.6	41.3	60.5	94.3	104.6	192.4	208.5	142.8	164.4	104.0	75.7	58.3	48.6	41.3
PE(t)	153.2	168.0	189.5	123.8	83.1	82.9	68.3	97.1	122.0	167.2	171.0	158.8	153.7	169.3	190.4	124.0	83.6	83.0	68.6	97.7
W(t)	1121.4	1111.5	1115.2	1046.1	1002.4	972.3	937.5	908.6	888.2	892.5	884.6	964.1	1050.8	1056.4	1073.7	1014.8	977.2	951.0	919.6	893.0
Y(t)	1062.7	1054.5	1057.6	999.4	961.5	935.1	904.2	878.2	859.8	863.7	856.5	927.8	1003.4	1008.2	1022.9	972.3	939.4	916.2	888.1	864.2
Sw(t)	968.0	951.9	942.2	926.7	914.0	889.0	867.3	827.7	798.2	780.0	771.7	842.2	913.6	909.3	910.8	901.5	892.7	871.0	851.8	814.2
Ro(t)	51.2	49.7	50.3	40.8	35.7	32.5	29.1	26.5	24.8	25.2	24.5	31.7	41.4	42.1	44.4	37.1	33.0	30.4	27.5	25.2
Rg(t)	7.4	7.2	7.3	5.9	5.2	4.7	4.2	3.8	3.6	3.7	3.6	4.6	6.0	6.1	6.4	5.4	4.8	4.4	4.0	3.7
Sg(t)	4600.9	4600.7	4600.6	4599.2	4597.0	4594.3	4591.2	4587.7	4583.9	4580.2	4576.4	4573.7	4572.4	4571.1	4570.2	4568.3	4565.7	4562.8	4559.5	4555.8
Qg(t)	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3
Q(t)	58.6	57.1	57.7	48.2	43.1	39.9	36.5	33.9	32.2	32.5	31.9	39.0	48.8	49.5	51.7	44.4	40.3	37.7	34.8	32.5
E(t)	94.7	102.6	115.4	72.7	47.5	46.1	36.9	50.5	61.6	83.7	84.8	85.6	89.7	98.9	112.1	70.8	46.7	45.2	36.4	50.0

	2031 741 S	742 O	743 N	744 D	2032 745 J	746 F	747 M	748 A	749 M	750 J	751 J	752 A	753 S	754 O	755 N	756 D	2033 757 J	758 F	759 M	760 A
P(t)	60.4	93.4	102.7	192.8	209.1	142.1	165.5	104.2	75.6	58.3	48.6	41.2	60.4	92.5	100.9	193.3	209.6	141.4	166.6	104.3
PE(t)	122.8	168.9	172.5	159.6	154.2	170.6	191.4	124.2	84.1	83.0	68.8	98.2	123.6	170.6	174.0	160.4	154.7	172.0	192.3	124.4
W(t)	874.6	879.8	871.5	953.1	1042.1	1048.6	1068.0	1010.2	973.3	947.5	916.6	890.3	872.0	876.2	865.9	948.4	1038.3	1044.7	1065.4	1007.8
Y(t)	847.5	852.1	844.6	918.1	995.9	1001.5	1018.1	968.3	936.0	913.1	885.5	861.7	845.0	848.9	839.5	913.9	992.7	998.2	1015.8	966.2
Sw(t)	786.3	768.7	760.3	833.0	906.5	902.6	906.0	897.7	889.2	868.1	849.1	811.6	783.7	765.0	755.0	828.7	903.3	898.8	903.4	895.6
Ro(t)	23.7	24.1	23.5	30.6	40.3	41.1	43.6	36.6	32.6	30.0	27.2	25.0	23.5	23.9	23.1	30.1	39.9	40.7	43.3	36.3
Rg(t)	3.4	3.5	3.4	4.4	5.9	6.0	6.3	5.3	4.7	4.4	3.9	3.6	3.4	3.5	3.3	4.4	5.8	5.9	6.3	5.3
Sg(t)	4552.0	4548.2	4544.3	4541.5	4540.0	4538.7	4537.8	4535.8	4533.2	4530.3	4527.0	4523.4	4519.5	4515.8	4511.9	4509.0	4507.5	4506.2	4505.3	4503.3
Qg(t)	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.2	7.2	7.2	7.2	7.2	7.2	7.2
Q(t)	31.0	31.4	30.8	37.9	47.6	48.4	50.9	43.8	39.9	37.3	34.5	32.2	30.8	31.1	30.3	37.4	47.1	47.9	50.5	43.5
E(t)	61.1	83.4	84.3	85.1	89.3	98.9	112.1	70.6	46.8	45.1	36.4	50.1	61.3	83.9	84.5	85.2	89.3	99.4	112.4	70.6

Appendix D (Continued)

Table D12. (Continued)

	2033 761 M	762 J	763 J	764 A	765 S	766 O	767 N	768 D	2034 769 J	770 F	771 M	772 A	773 M	774 J	775 J	776 A	777 S	778 O	779 N	780 D
P(t)	75.6	58.3	48.6	41.2	60.3	91.6	99.1	193.8	210.2	140.7	167.7	104.5	75.5	58.4	48.6	41.2	60.2	90.7	97.3	194.3
PE(t)	84.6	83.0	69.1	98.8	124.4	172.4	175.5	161.3	155.2	173.4	193.3	124.6	85.1	83.1	69.4	99.4	125.2	174.2	177.1	162.2
W(t)	971.2	945.5	914.9	888.7	870.3	873.5	861.1	944.1	1035.0	1041.1	1063.0	1005.6	969.3	943.7	913.4	887.2	868.6	870.8	856.3	940.0
Y(t)	934.2	911.4	884.0	860.2	843.5	846.4	835.1	910.1	989.8	995.1	1013.8	964.3	932.5	909.7	882.5	858.9	842.0	844.0	830.7	906.4
Sw(t)	887.2	866.4	847.5	810.0	781.9	762.0	750.3	824.9	900.5	895.3	901.1	893.8	885.3	864.8	846.0	808.4	780.1	759.0	745.7	821.1
Ro(t)	32.4	29.9	27.1	24.9	23.4	23.6	22.7	29.7	39.5	40.2	43.0	36.0	32.2	29.7	26.9	24.7	23.3	23.4	22.3	29.3
Rg(t)	4.7	4.3	3.9	3.6	3.4	3.4	3.3	4.3	5.7	5.8	6.2	5.2	4.7	4.3	3.9	3.6	3.4	3.4	3.2	4.3
Sg(t)	4500.8	4497.9	4494.6	4491.0	4487.2	4483.4	4479.5	4476.7	4475.2	4473.9	4472.9	4471.0	4468.5	4465.6	4462.4	4458.8	4455.0	4451.3	4447.4	4444.5
Qg(t)	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.1	7.1	7.1	7.1
Q(t)	39.6	37.1	34.3	32.1	30.6	30.8	29.9	36.9	46.6	47.4	50.2	43.2	39.4	36.8	34.1	31.9	30.4	30.6	29.5	36.5
E(t)	47.0	45.0	36.5	50.3	61.6	84.4	84.7	85.2	89.4	99.8	112.7	70.5	47.1	44.9	36.5	50.5	61.9	85.0	85.0	85.3
	2035 781 J	782 F	783 M	784 A	785 M	786 J	787 J	788 A	789 S	790 O	791 N	792 D	2036 793 J	794 F	795 M	796 A	797 M	798 J	799 J	800 A
P(t)	210.7	140.0	168.8	104.6	75.5	58.4	48.6	41.2	60.2	89.8	95.6	194.8	211.2	139.3	170.0	104.8	75.5	58.5	48.6	41.1
PE(t)	155.7	174.8	194.3	124.8	85.6	83.1	69.6	100.0	126.0	176.0	178.7	163.0	156.2	176.2	195.3	125.0	86.1	83.1	69.9	100.6
W(t)	1031.8	1037.6	1060.6	1003.4	967.4	941.8	911.8	885.7	867.0	868.2	851.5	935.8	1028.5	1034.1	1058.2	1001.2	965.5	940.0	910.2	884.1
Y(t)	987.0	992.0	1011.8	962.4	930.8	908.1	881.1	857.5	840.5	841.6	826.3	902.7	984.2	989.0	1009.7	960.5	929.1	906.4	879.7	856.1
Sw(t)	897.6	891.8	898.7	891.9	883.4	863.2	844.5	806.8	778.3	755.9	741.0	817.3	894.8	888.3	896.4	890.0	881.5	861.6	843.0	805.2
Ro(t)	39.1	39.8	42.7	35.8	32.0	29.5	26.8	24.6	23.1	23.2	22.0	28.9	38.7	39.3	42.4	35.6	31.8	29.3	26.7	24.5
Rg(t)	5.7	5.8	6.2	5.2	4.6	4.3	3.9	3.6	3.4	3.4	3.2	4.2	5.6	5.7	6.1	5.2	4.6	4.3	3.9	3.6
Sg(t)	4443.0	4441.7	4440.8	4438.8	4436.3	4433.5	4430.3	4426.8	4423.0	4419.3	4415.4	4412.5	4411.1	4409.7	4408.8	4406.8	4404.4	4401.6	4398.4	4394.9
Qg(t)	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1
Q(t)	46.2	46.9	49.8	42.9	39.1	36.6	33.9	31.7	30.2	30.3	29.1	36.0	45.8	46.4	49.4	42.6	38.9	36.4	33.7	31.5
E(t)	89.4	100.3	113.0	70.5	47.3	44.9	36.6	50.7	62.1	85.6	85.3	85.4	89.4	100.7	113.3	70.5	47.5	44.8	36.7	50.9

Appendix D (Continued)

Table D12. (Continued)

	2036				2037												2038			
	801	802	803	804	805	806	807	808	809	810	811	812	813	814	815	816	817	818	819	820
	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A
P(t)	60.1	89.0	93.9	195.2	211.8	138.6	171.1	104.9	75.4	58.5	48.6	41.1	60.1	88.1	92.2	195.7	212.3	137.9	172.3	105.1
PE(t)	126.8	177.9	180.3	163.9	156.8	177.6	196.3	125.2	86.7	83.2	70.1	101.2	127.7	179.8	182.0	164.8	157.3	179.1	197.3	125.4
W(t)	865.3	865.5	846.7	931.6	1025.2	1030.5	1055.9	999.0	963.5	938.1	908.6	882.6	863.6	862.8	842.0	927.5	1022.0	1027.0	1053.5	996.8
Y(t)	838.9	839.1	822.0	898.9	981.4	985.9	1007.7	958.5	927.4	904.7	878.2	854.7	837.4	836.7	817.6	895.2	978.6	982.9	1005.7	956.6
Sw(t)	776.5	752.9	736.4	813.5	891.9	884.7	894.1	888.1	879.6	860.0	841.5	803.6	774.7	749.8	731.8	809.7	889.1	881.2	891.7	886.2
Ro(t)	23.0	23.0	21.6	28.6	38.3	38.9	42.1	35.3	31.6	29.2	26.5	24.4	22.9	22.8	21.3	28.2	37.9	38.5	41.8	35.1
Rg(t)	3.3	3.3	3.1	4.1	5.6	5.6	6.1	5.1	4.6	4.2	3.8	3.5	3.3	3.3	3.1	4.1	5.5	5.6	6.1	5.1
Sg(t)	4391.2	4387.5	4383.6	4380.7	4379.2	4377.9	4376.9	4375.0	4372.6	4369.8	4366.7	4363.2	4359.5	4355.8	4351.9	4349.1	4347.6	4346.2	4345.3	4343.4
Qg(t)	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
Q(t)	30.1	30.1	28.7	35.6	45.3	45.9	49.1	42.3	38.6	36.2	33.5	31.4	29.9	29.8	28.3	35.2	44.9	45.5	48.7	42.0
E(t)	62.4	86.2	85.6	85.5	89.5	101.2	113.6	70.4	47.7	44.7	36.8	51.1	62.7	86.8	85.9	85.6	89.5	101.7	114.0	70.4

	2038								2039											
	821	822	823	824	825	826	827	828	829	830	831	832	833	834	835	836	837	838	839	840
	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
P(t)	75.4	58.5	48.6	41.1	60.0	87.2	90.5	196.2	215.3	138.3	181.6	105.6	75.3	58.6	48.6	41.0	59.8	87.3	95.9	198.8
PE(t)	87.2	83.2	70.4	101.8	128.5	181.7	183.7	165.7	159.2	181.1	201.1	125.7	89.8	83.0	71.7	104.6	131.2	190.8	189.3	169.2
W(t)	961.6	936.2	907.0	881.0	861.9	860.1	837.3	923.4	1021.1	1025.7	1060.8	1000.8	964.5	937.4	908.1	881.3	860.6	857.8	836.6	922.9
Y(t)	925.6	903.1	876.8	853.3	835.9	834.2	813.3	891.5	977.8	981.8	1011.9	960.1	928.2	904.1	877.8	853.5	834.7	832.1	812.7	891.1
Sw(t)	877.7	858.4	839.9	802.0	772.9	746.8	727.1	805.8	887.4	879.2	895.1	889.3	878.8	859.5	840.2	800.8	770.5	740.7	724.1	803.8
Ro(t)	31.4	29.0	26.4	24.2	22.8	22.6	21.0	27.8	37.8	38.4	42.7	35.5	31.7	29.1	26.5	24.3	22.7	22.4	20.9	27.8
Rg(t)	4.6	4.2	3.8	3.5	3.3	3.3	3.0	4.0	5.5	5.6	6.2	5.2	4.6	4.2	3.8	3.5	3.3	3.3	3.0	4.0
Sg(t)	4341.0	4338.2	4335.1	4331.7	4328.0	4324.4	4320.5	4317.6	4316.1	4314.8	4314.1	4312.3	4310.0	4307.3	4304.2	4300.8	4297.2	4293.6	4289.7	4286.9
Qg(t)	7.0	7.0	7.0	7.0	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9
Q(t)	38.4	35.9	33.3	31.2	29.7	29.6	27.9	34.7	44.7	45.3	49.6	42.4	38.6	36.0	33.4	31.2	29.6	29.3	27.8	34.7
E(t)	47.9	44.7	36.8	51.3	63.0	87.5	86.2	85.7	90.4	102.6	116.7	70.8	49.4	44.6	37.6	52.7	64.1	91.4	88.6	87.4

Appendix D (Continued)

Table D12. (Continued)

	2040												2041							
	841	842	843	844	845	846	847	848	849	850	851	852	853	854	855	856	857	858	859	860
	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A
P(t)	215.8	137.6	182.8	105.8	75.2	58.7	48.6	41.0	59.8	86.4	94.2	199.3	215.7	137.2	183.1	105.9	75.0	58.6	48.6	41.0
PE(t)	159.7	182.6	202.1	125.9	90.4	83.0	72.0	105.2	132.1	192.9	191.1	170.2	161.3	185.3	204.3	127.4	91.2	83.6	72.4	106.2
W(t)	1019.6	1023.5	1059.5	999.4	963.3	936.1	907.0	880.1	859.2	855.4	832.0	918.8	1015.7	1019.2	1055.0	994.9	958.7	931.7	902.9	876.4
Y(t)	976.5	979.9	1010.8	958.9	927.1	902.9	876.8	852.4	833.4	829.9	808.4	887.4	973.1	976.1	1006.9	955.0	923.0	899.0	873.1	849.1
Sw(t)	885.9	876.6	893.6	888.0	877.4	858.4	839.1	799.4	768.9	737.8	719.5	800.0	882.0	871.9	889.0	883.6	873.1	854.3	835.4	795.8
Ro(t)	37.6	38.1	42.5	35.4	31.6	29.0	26.4	24.2	22.6	22.3	20.6	27.4	37.2	37.6	41.9	34.9	31.1	28.6	26.0	23.9
Rg(t)	5.5	5.5	6.2	5.1	4.6	4.2	3.8	3.5	3.3	3.2	3.0	4.0	5.4	5.5	6.1	5.1	4.5	4.1	3.8	3.5
Sg(t)	4285.5	4284.1	4283.4	4281.7	4279.4	4276.7	4273.7	4270.4	4266.8	4263.2	4259.3	4256.5	4255.0	4253.7	4252.9	4251.2	4248.9	4246.2	4243.2	4239.8
Qg(t)	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8
Q(t)	44.5	45.0	49.4	42.2	38.4	35.8	33.2	31.0	29.4	29.1	27.4	34.2	44.0	44.4	48.8	41.7	37.9	35.4	32.8	30.7
E(t)	90.6	103.3	117.2	70.8	49.7	44.6	37.7	53.0	64.5	92.1	88.9	87.5	91.1	104.3	117.9	71.4	49.9	44.7	37.7	53.2
	2041				2042												2043			
	861	862	863	864	865	866	867	868	869	870	871	872	873	874	875	876	877	878	879	880
	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A
P(t)	59.7	85.1	67.5	198.2	215.6	136.7	183.4	106.1	74.9	58.6	48.6	40.9	59.6	83.8	48.4	197.2	215.5	136.3	183.6	106.2
PE(t)	133.7	196.2	194.8	172.3	162.8	188.1	206.5	129.0	92.1	84.3	72.7	107.1	135.3	199.5	198.6	174.4	164.4	190.9	208.7	130.6
W(t)	855.5	850.2	799.6	889.6	990.8	998.2	1037.5	980.7	946.1	920.6	893.1	867.7	847.6	841.4	771.9	864.1	968.8	979.4	1021.6	967.6
Y(t)	830.0	825.1	778.5	861.1	951.4	957.9	992.0	942.5	911.8	889.1	864.3	841.1	822.7	817.0	752.7	837.8	932.0	941.4	978.2	930.9
Sw(t)	765.1	732.1	691.4	775.2	861.5	854.1	874.6	871.2	862.0	844.5	826.8	788.0	757.6	723.5	666.9	753.3	843.1	838.0	861.3	859.7
Ro(t)	22.3	21.9	18.4	24.9	34.4	35.2	39.8	33.4	29.9	27.6	25.2	23.2	21.7	21.2	16.7	22.9	32.1	33.2	37.9	32.0
Rg(t)	3.2	3.2	2.7	3.6	5.0	5.1	5.8	4.8	4.3	4.0	3.7	3.4	3.1	3.1	2.4	3.3	4.7	4.8	5.5	4.6
Sg(t)	4236.2	4232.6	4228.5	4225.4	4223.6	4221.9	4220.9	4219.0	4216.5	4213.8	4210.7	4207.3	4203.7	4200.0	4195.7	4192.3	4190.3	4188.4	4187.2	4185.1
Qg(t)	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7
Q(t)	29.1	28.7	25.2	31.7	41.2	42.0	46.5	40.1	36.7	34.3	32.0	29.9	28.4	28.0	23.5	29.6	38.9	39.9	44.6	38.7
E(t)	65.0	93.0	87.2	85.9	89.9	103.8	117.3	71.3	49.8	44.5	37.5	53.2	65.2	93.6	85.9	84.5	88.9	103.4	116.9	71.2

Appendix D (Continued)

Table D12. (Continued)

	2043 881 M	882 J	883 J	884 A	885 S	886 O	887 N	888 D	2044 889 J	890 F	891 M	892 A	893 M	894 J	895 J	896 A	897 S	898 O	899 N	900 D
P(t)	74.7	58.6	48.6	40.9	59.5	82.5	34.7	196.1	215.4	135.9	183.9	106.4	74.5	58.5	48.6	40.9	59.4	81.2	24.9	195.1
PE(t)	93.1	85.0	73.1	108.0	137.0	203.0	202.6	176.6	166.0	193.8	211.0	132.2	94.0	85.6	73.5	109.0	138.8	206.6	206.7	178.9
W(t)	934.3	910.2	883.9	859.5	840.0	832.9	749.8	843.1	950.5	963.5	1007.8	956.0	923.8	900.8	875.5	851.9	833.0	824.9	731.9	825.7
Y(t)	901.4	879.7	855.9	833.6	815.8	809.2	732.1	818.6	915.8	927.3	966.3	920.6	891.9	871.2	848.2	826.7	809.3	801.9	715.3	802.6
Sw(t)	851.6	835.3	818.6	780.5	750.4	715.0	647.0	735.1	827.6	823.9	849.6	849.3	842.3	826.9	811.1	773.6	743.7	707.0	630.6	719.7
Ro(t)	28.8	26.7	24.5	22.6	21.1	20.6	15.5	21.4	30.3	31.6	36.3	30.9	27.9	25.9	23.8	22.0	20.7	20.1	14.5	20.1
Rg(t)	4.2	3.9	3.5	3.3	3.1	3.0	2.2	3.1	4.4	4.6	5.3	4.5	4.0	3.8	3.5	3.2	3.0	2.9	2.1	2.9
Sg(t)	4182.5	4179.7	4176.6	4173.1	4169.5	4165.8	4161.4	4157.8	4155.5	4153.5	4152.1	4149.9	4147.3	4144.4	4141.2	4137.7	4134.1	4130.4	4125.9	4122.2
Qg(t)	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.6	6.6	6.6	6.6	6.6	6.6
Q(t)	35.5	33.4	31.2	29.3	27.8	27.3	22.1	28.0	37.0	38.3	43.0	37.5	34.5	32.5	30.4	28.7	27.3	26.7	21.1	26.8
E(t)	49.7	44.4	37.3	53.1	65.4	94.2	85.1	83.6	88.2	103.3	116.7	71.3	49.7	44.3	37.1	53.2	65.7	94.9	84.7	82.9
	2045 901 J	902 F	903 M	904 A	905 M	906 J	907 J	908 A	909 S	910 O	911 N	912 D	2046 913 J	914 F	915 M	916 A	917 M	918 J	919 J	920 A
P(t)	215.3	135.4	184.2	106.5	74.3	58.5	48.6	40.9	59.3	80.0	17.9	194.0	215.2	135.0	184.4	106.7	74.1	58.5	48.6	40.8
PE(t)	167.7	196.8	213.4	133.9	95.0	86.3	73.8	110.0	140.6	210.3	210.9	181.2	169.4	199.9	215.8	135.7	96.0	87.0	74.2	111.0
W(t)	935.0	949.7	995.8	945.7	914.3	892.2	867.7	845.0	826.4	817.3	717.1	810.8	921.5	937.6	984.9	936.2	905.5	884.1	860.4	838.4
Y(t)	901.9	915.1	955.7	911.5	883.4	863.4	841.1	820.4	803.3	794.9	701.4	788.8	889.9	904.2	946.2	903.0	875.4	856.1	834.5	814.3
Sw(t)	814.3	811.6	839.1	840.0	833.7	819.1	804.1	767.2	737.3	699.3	616.8	706.3	802.6	800.5	829.6	831.4	825.7	811.9	797.6	761.1
Ro(t)	28.9	30.3	35.0	29.9	27.0	25.1	23.2	21.5	20.2	19.6	13.7	19.1	27.6	29.1	33.8	29.0	26.3	24.5	22.6	21.0
Rg(t)	4.2	4.4	5.1	4.3	3.9	3.6	3.4	3.1	2.9	2.8	2.0	2.8	4.0	4.2	4.9	4.2	3.8	3.6	3.3	3.1
Sg(t)	4119.8	4117.5	4116.0	4113.7	4111.1	4108.1	4104.9	4101.4	4097.8	4094.1	4089.5	4085.7	4083.2	4080.8	4079.2	4076.9	4074.1	4071.1	4067.9	4064.4
Qg(t)	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.5	6.5	6.5	6.5	6.5	6.5	6.5
Q(t)	35.5	36.9	41.6	36.5	33.6	31.7	29.8	28.1	26.8	26.2	20.3	25.7	34.2	35.7	40.3	35.5	32.8	31.0	29.2	27.6
E(t)	87.6	103.5	116.6	71.5	49.7	44.3	37.0	53.2	66.0	95.6	84.6	82.5	87.3	103.8	116.6	71.7	49.8	44.2	36.9	53.3

Appendix D (Continued)

Table D12. (Continued)

	2046 921 S	922 O	923 N	924 D	2047 925 J	926 F	927 M	928 A	929 M	930 J	931 J	932 A	933 S	934 O	935 N	936 D	2048 937 J	938 F	939 M	940 A
P(t)	59.2	78.8	12.8	193.0	215.1	134.6	184.7	106.8	74.0	58.4	48.6	40.8	59.1	77.6	9.2	191.9	215.0	134.1	185.0	107.0
PE(t)	142.4	214.1	215.3	183.6	171.1	203.1	218.3	137.5	97.0	87.7	74.6	112.0	144.3	218.0	219.9	186.0	172.9	206.4	220.8	139.3
W(t)	820.2	810.0	704.5	797.6	909.5	926.6	974.9	927.4	897.2	876.5	853.5	832.2	814.3	802.9	693.5	785.8	898.6	916.4	965.5	919.1
Y(t)	797.6	788.2	689.5	776.7	879.1	894.4	937.4	895.2	867.9	849.2	828.2	808.6	792.1	781.6	679.1	765.7	869.2	885.2	929.1	887.7
Sw(t)	731.3	691.7	604.7	694.4	792.0	790.2	820.6	823.2	818.1	804.9	791.3	755.2	725.4	684.3	593.9	683.6	782.2	780.6	812.1	815.4
Ro(t)	19.8	19.1	13.1	18.3	26.6	28.1	32.8	28.2	25.6	23.9	22.1	20.6	19.4	18.6	12.6	17.6	25.7	27.2	31.8	27.4
Rg(t)	2.9	2.8	1.9	2.7	3.9	4.1	4.8	4.1	3.7	3.5	3.2	3.0	2.8	2.7	1.8	2.5	3.7	3.9	4.6	4.0
Sg(t)	4060.8	4057.0	4052.4	4048.6	4046.0	4043.6	4041.8	4039.4	4036.7	4033.7	4030.4	4026.9	4023.3	4019.5	4014.9	4011.0	4008.3	4005.8	4004.0	4001.6
Qg(t)	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.4	6.4	6.4	6.4	6.4	6.4
Q(t)	26.3	25.6	19.6	24.8	33.1	34.6	39.2	34.7	32.0	30.4	28.6	27.1	25.8	25.1	19.0	24.0	32.1	33.6	38.2	33.9
E(t)	66.3	96.4	84.8	82.2	87.1	104.2	116.8	72.0	49.8	44.2	36.8	53.4	66.7	97.3	85.2	82.1	86.9	104.7	117.0	72.3
	2048 941 M	942 J	943 J	944 A	945 S	946 O	947 N	948 D	2049 949 J	950 F	951 M	952 A	953 M	954 J	955 J	956 A	957 S	958 O	959 N	960 D
P(t)	73.8	58.4	48.6	40.8	59.0	76.4	6.6	190.9	214.9	133.7	185.2	107.1	73.6	58.3	48.5	40.8	58.9	75.2	4.7	189.9
PE(t)	98.0	88.5	75.0	113.1	146.3	222.1	224.6	188.5	174.7	209.8	223.4	141.2	99.1	89.2	75.4	114.2	148.3	226.3	229.5	191.1
W(t)	889.2	869.1	846.8	826.1	808.5	796.0	683.5	774.9	888.3	906.8	956.6	911.0	881.4	861.9	840.2	820.1	802.7	789.0	674.4	764.5
Y(t)	860.7	842.4	822.0	803.0	786.7	775.1	669.7	755.5	859.9	876.6	921.2	880.4	853.6	835.9	815.9	797.4	781.4	768.7	661.0	745.9
Sw(t)	810.8	798.2	785.3	749.5	719.6	677.0	584.0	673.5	773.0	771.3	803.9	807.8	803.6	791.6	779.3	743.8	713.8	669.6	574.7	663.8
Ro(t)	24.9	23.3	21.6	20.2	19.0	18.2	12.1	16.9	24.8	26.4	30.9	26.7	24.3	22.8	21.2	19.8	18.6	17.8	11.7	16.3
Rg(t)	3.6	3.4	3.1	2.9	2.8	2.6	1.8	2.5	3.6	3.8	4.5	3.9	3.5	3.3	3.1	2.9	2.7	2.6	1.7	2.4
Sg(t)	3998.8	3995.7	3992.5	3989.0	3985.4	3981.6	3977.0	3973.1	3970.3	3967.8	3965.9	3963.4	3960.6	3957.5	3954.2	3950.8	3947.1	3943.4	3938.8	3934.8
Qg(t)	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.3	6.3	6.3	6.3	6.3	6.3
Q(t)	31.3	29.7	28.0	26.6	25.4	24.6	18.5	23.3	31.2	32.7	37.3	33.1	30.6	29.1	27.5	26.1	25.0	24.1	18.0	22.6
E(t)	49.9	44.2	36.7	53.5	67.1	98.2	85.7	82.0	86.9	105.2	117.3	72.6	50.0	44.2	36.6	53.6	67.5	99.1	86.3	82.0

Appendix D (Continued)

Table D12. (Continued)

	2050 961 J	962 F	963 M	964 A	965 M	966 J	967 J	968 A	969 S	970 O	971 N	972 D
P(t)	214.8	133.3	185.5	107.3	73.4	58.3	48.5	40.7	58.8	74.0	3.4	188.8
PE(t)	176.5	213.2	226.0	143.1	100.2	90.0	75.8	115.3	150.3	230.7	234.6	193.8
W(t)	878.6	897.5	947.9	903.1	873.8	854.8	833.6	814.1	797.0	782.2	665.7	754.6
Y(t)	851.1	868.2	913.4	873.3	846.7	829.4	809.9	791.9	776.1	762.3	652.7	736.6
Sw(t)	764.2	762.4	795.9	800.3	796.5	785.1	773.4	738.2	708.1	662.3	565.7	654.5
Ro(t)	24.0	25.6	30.1	26.1	23.7	22.2	20.7	19.4	18.3	17.3	11.3	15.7
Rg(t)	3.5	3.7	4.4	3.8	3.4	3.2	3.0	2.8	2.6	2.5	1.6	2.3
Sg(t)	3932.0	3929.4	3927.5	3924.9	3922.1	3919.0	3915.7	3912.3	3908.6	3904.9	3900.3	3896.3
Qg(t)	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3
Q(t)	30.4	31.9	36.4	32.3	30.0	28.5	27.0	25.6	24.5	23.6	17.6	22.0
E(t)	86.8	105.8	117.6	73.0	50.2	44.3	36.6	53.7	68.0	100.0	87.0	82.1

Appendix D (Continued)

Table 13. Water balance output values – moderate growth and B1 scenarios (2010-2050) .

	2010												2011							
	481	482	483	484	485	486	487	488	489	490	491	492	493	494	495	496	497	498	499	500
	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A
P(t)	292.8	199.5	119.7	100.3	83.1	7.1	55.2	46.8	74.6	113.4	154.9	188.8	198.1	157.8	143.8	101.2	76.4	57.6	48.5	41.8
PE(t)	144.0	145.2	172.7	120.1	74.6	82.2	63.8	87.3	108.4	138.6	145.4	144.0	144.6	145.8	173.1	120.6	74.7	82.4	64.1	87.6
W(t)	1395.0	1432.9	1380.1	1301.9	1260.7	1182.1	1157.3	1139.0	1135.5	1158.2	1200.5	1265.9	1330.2	1307.3	1276.2	1193.1	1139.6	1106.7	1065.3	1034.5
Y(t)	1343.1	1373.4	1330.8	1264.3	1228.1	1157.0	1134.2	1117.2	1114.0	1135.0	1173.8	1232.7	1253.8	1236.1	1211.5	1143.0	1097.2	1068.4	1031.7	1004.0
Sw(t)	1233.4	1260.4	1201.6	1177.6	1175.0	1102.1	1092.2	1061.0	1044.8	1045.6	1077.1	1132.1	1149.5	1132.4	1091.9	1063.2	1049.1	1016.9	992.8	952.6
Ro(t)	40.2	46.0	38.1	29.0	25.2	19.4	17.9	16.8	16.7	17.9	20.6	25.7	62.9	58.6	53.3	41.2	34.9	31.5	27.7	25.1
Rg(t)	11.8	13.5	11.2	8.5	7.4	5.7	5.2	4.9	4.9	5.3	6.0	7.5	13.5	12.6	11.4	8.8	7.5	6.8	5.9	5.4
Sg(t)	4806.6	4813.3	4817.8	4819.5	4820.1	4819.0	4817.5	4815.7	4813.8	4812.3	4811.6	4812.4	4818.6	4823.9	4828.1	4829.7	4829.9	4829.4	4828.1	4826.2
Qg(t)	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3
Q(t)	46.9	52.8	44.9	35.8	32.0	26.2	24.7	23.6	23.4	24.7	27.4	32.4	70.2	65.9	60.5	48.5	42.2	38.8	34.9	32.4
E(t)	109.7	113.0	129.2	86.7	53.0	54.9	42.0	56.2	69.2	89.4	96.7	100.6	104.3	103.6	119.6	79.8	48.1	51.6	39.0	51.4

	2011				2012												2013			
	501	502	503	504	505	506	507	508	509	510	511	512	513	514	515	516	517	518	519	520
	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A
P(t)	61.6	113.6	147.4	183.5	198.8	158.5	144.4	101.8	77.0	58.2	49.0	42.2	62.2	114.3	148.1	184.2	199.5	159.3	145.1	102.5
PE(t)	109.0	139.5	146.3	144.6	145.3	146.5	173.6	121.0	74.8	82.5	64.5	87.9	109.6	140.5	147.3	145.2	145.9	147.2	174.0	121.5
W(t)	1014.2	1036.8	1072.6	1134.4	1200.6	1211.9	1205.7	1141.3	1098.6	1072.9	1037.3	1010.5	994.0	1019.9	1058.7	1123.1	1191.9	1205.5	1201.0	1138.1
Y(t)	985.6	1006.1	1038.3	1092.7	1149.4	1158.9	1153.6	1098.7	1061.3	1038.5	1006.5	982.3	967.2	990.8	1025.8	1082.9	1142.1	1153.5	1149.7	1095.9
Sw(t)	923.2	925.2	950.9	1001.8	1053.4	1061.3	1039.5	1021.7	1014.7	988.3	968.3	931.8	905.6	910.6	939.0	992.4	1046.2	1055.9	1035.6	1018.8
Ro(t)	23.5	25.3	28.3	34.3	42.2	43.7	42.8	35.1	30.7	28.3	25.3	23.3	22.1	24.0	27.1	33.2	41.0	42.8	42.2	34.7
Rg(t)	5.1	5.4	6.1	7.4	9.1	9.4	9.2	7.5	6.6	6.1	5.4	5.0	4.7	5.1	5.8	7.1	8.8	9.2	9.1	7.5
Sg(t)	4824.0	4822.2	4821.0	4821.1	4822.9	4825.0	4826.9	4827.2	4826.5	4825.3	4823.5	4821.3	4818.7	4816.6	4815.2	4815.1	4816.6	4818.6	4820.4	4820.6
Qg(t)	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.2	7.2	7.2	7.2	7.3	7.3	7.3
Q(t)	30.8	32.5	35.6	41.6	49.4	50.9	50.1	42.3	38.0	35.6	32.6	30.5	29.3	31.2	34.3	40.4	48.3	50.1	49.5	42.0
E(t)	62.4	80.9	87.3	90.9	96.0	97.6	114.2	77.0	46.6	50.2	38.2	50.5	61.6	80.2	86.8	90.4	95.8	97.6	114.1	77.1

Appendix D (Continued)

Table D13. (Continued)

	2013 521 M	522 J	523 J	524 A	525 S	526 O	527 N	528 D	2014 529 J	530 F	531 M	532 A	533 M	534 J	535 J	536 A	537 S	538 O	539 N	540 D
P(t)	77.6	58.7	49.5	42.7	62.8	114.9	148.8	184.9	200.2	160.0	145.8	103.1	78.2	59.3	50.1	43.2	63.4	115.6	149.5	185.6
PE(t)	74.9	82.7	64.8	88.2	110.2	141.4	148.3	145.9	146.6	147.9	174.5	121.9	75.0	82.8	65.2	88.5	110.8	142.4	149.3	146.5
W(t)	1096.4	1071.5	1036.5	1010.2	994.1	1020.3	1059.2	1123.7	1192.7	1206.4	1201.9	1139.2	1097.6	1073.0	1038.2	1012.0	996.1	1022.3	1061.1	1125.3
Y(t)	1059.4	1037.2	1005.8	982.0	967.3	991.2	1026.3	1083.4	1142.7	1154.3	1150.5	1096.8	1060.4	1038.6	1007.4	983.6	969.1	993.0	1027.9	1084.8
Sw(t)	1012.8	987.0	967.4	931.3	905.4	910.5	938.8	992.5	1046.4	1056.2	1036.0	1019.4	1013.7	988.2	968.7	932.7	906.7	911.6	939.8	993.4
Ro(t)	30.5	28.2	25.3	23.2	22.1	24.0	27.1	33.2	41.1	42.9	42.3	34.8	30.6	28.3	25.4	23.4	22.2	24.2	27.3	33.4
Rg(t)	6.5	6.1	5.4	5.0	4.7	5.2	5.8	7.1	8.8	9.2	9.1	7.5	6.6	6.1	5.5	5.0	4.8	5.2	5.9	7.2
Sg(t)	4819.9	4818.7	4816.9	4814.6	4812.1	4810.0	4808.6	4808.5	4810.1	4812.1	4813.9	4814.2	4813.5	4812.3	4810.5	4808.3	4805.8	4803.8	4802.4	4802.4
Qg(t)	7.3	7.3	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2
Q(t)	37.8	35.5	32.5	30.5	29.3	31.2	34.4	40.4	48.4	50.2	49.6	42.1	37.9	35.6	32.6	30.6	29.4	31.4	34.5	40.6
E(t)	46.6	50.2	38.4	50.6	61.9	80.7	87.4	90.8	96.3	98.1	114.5	77.4	46.7	50.4	38.7	50.9	62.4	81.4	88.2	91.4

	2015 541 J	542 F	543 M	544 A	545 M	546 J	547 J	548 A	549 S	550 O	551 N	552 D	2016 553 J	554 F	555 M	556 A	557 M	558 J	559 J	560 A
P(t)	200.9	160.8	146.4	103.8	78.8	59.9	50.6	43.8	64.0	116.2	150.2	186.3	201.6	161.5	147.1	104.5	79.4	60.5	51.1	44.3
PE(t)	147.3	148.6	175.0	122.4	75.1	83.0	65.5	88.8	111.4	143.3	150.3	147.1	148.0	149.3	175.5	122.8	75.2	83.1	65.9	89.1
W(t)	1194.3	1208.0	1203.4	1140.6	1099.1	1074.8	1040.2	1014.0	998.2	1024.5	1063.0	1127.1	1196.0	1209.6	1204.8	1142.1	1100.6	1076.6	1042.2	1016.0
Y(t)	1144.1	1155.6	1151.7	1098.1	1061.7	1040.2	1009.2	985.4	971.0	994.9	1029.7	1086.3	1145.5	1157.0	1152.9	1099.4	1063.1	1041.8	1010.9	987.2
Sw(t)	1047.2	1056.9	1036.8	1020.3	1014.9	989.6	970.2	934.2	908.2	912.9	940.8	994.4	1048.1	1057.7	1037.6	1021.2	1016.1	991.0	971.7	935.8
Ro(t)	41.4	43.1	42.5	35.0	30.8	28.5	25.6	23.5	22.4	24.3	27.5	33.6	41.6	43.4	42.7	35.2	30.9	28.7	25.7	23.7
Rg(t)	8.9	9.3	9.1	7.5	6.6	6.1	5.5	5.0	4.8	5.2	5.9	7.2	8.9	9.3	9.2	7.5	6.6	6.2	5.5	5.1
Sg(t)	4804.0	4806.1	4807.9	4808.2	4807.6	4806.5	4804.7	4802.6	4800.1	4798.1	4796.8	4796.8	4798.5	4800.6	4802.5	4802.8	4802.2	4801.2	4799.5	4797.3
Qg(t)	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2
Q(t)	48.6	50.4	49.8	42.2	38.0	35.7	32.8	30.7	29.6	31.5	34.7	40.8	48.8	50.6	49.9	42.4	38.1	35.9	32.9	30.9
E(t)	96.9	98.7	114.9	77.8	46.8	50.5	38.9	51.2	62.8	82.1	88.9	91.9	97.4	99.2	115.3	78.2	47.0	50.7	39.2	51.4

Appendix D (Continued)

Table D13. (Continued)

	2016 561 S	562 O	563 N	564 D	2017 565 J	566 F	567 M	568 A	569 M	570 J	571 J	572 A	573 S	574 O	575 N	576 D	2018 577 J	578 F	579 M	580 A
P(t)	64.6	116.9	150.9	187.0	202.3	162.3	147.8	105.1	80.0	61.1	51.7	44.8	65.2	117.5	151.6	187.7	203.0	163.0	148.5	105.8
PE(t)	112.0	144.3	151.4	147.8	148.7	150.0	175.9	123.3	75.4	83.3	66.3	89.4	112.6	145.3	152.4	148.5	149.4	150.8	176.4	123.8
W(t)	1000.4	1026.6	1065.0	1128.8	1197.7	1211.2	1206.3	1143.6	1102.1	1078.4	1044.2	1018.0	1002.5	1028.8	1067.0	1130.5	1199.3	1212.8	1207.7	1145.0
Y(t)	973.0	996.9	1031.4	1087.8	1146.9	1158.3	1154.2	1100.7	1064.4	1043.4	1012.7	989.1	975.0	998.9	1033.2	1089.3	1148.3	1159.6	1155.4	1101.9
Sw(t)	909.7	914.1	941.8	995.4	1049.0	1058.5	1038.4	1022.1	1017.3	992.5	973.2	937.4	911.3	915.4	942.8	996.4	1049.8	1059.3	1039.2	1023.0
Ro(t)	22.5	24.5	27.6	33.7	41.8	43.6	42.9	35.3	31.0	28.8	25.9	23.8	22.7	24.7	27.8	33.9	42.0	43.8	43.1	35.5
Rg(t)	4.8	5.3	5.9	7.2	9.0	9.4	9.2	7.6	6.7	6.2	5.6	5.1	4.9	5.3	6.0	7.3	9.0	9.4	9.3	7.6
Sg(t)	4795.0	4793.0	4791.7	4791.8	4793.5	4795.6	4797.6	4798.0	4797.4	4796.4	4794.8	4792.7	4790.3	4788.4	4787.2	4787.2	4789.1	4791.2	4793.3	4793.7
Qg(t)	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2
Q(t)	29.7	31.7	34.8	41.0	49.0	50.8	50.1	42.5	38.3	36.0	33.1	31.0	29.9	31.9	35.0	41.1	49.2	51.0	50.3	42.7
E(t)	63.3	82.7	89.6	92.4	98.0	99.8	115.7	78.6	47.1	50.9	39.5	51.7	63.7	83.5	90.4	92.9	98.5	100.4	116.1	78.9

	2018 581 M	582 J	583 J	584 A	585 S	586 O	587 N	588 D	2019 589 J	590 F	591 M	592 A	593 M	594 J	595 J	596 A	597 S	598 O	599 N	600 D
P(t)	80.6	61.7	52.2	45.3	65.8	118.2	152.3	188.4	203.7	163.8	149.2	106.5	81.2	62.3	52.8	45.9	66.4	118.9	153.0	189.1
PE(t)	75.5	83.4	66.6	89.7	113.2	146.3	153.5	149.1	150.1	151.5	176.9	124.3	75.6	83.6	67.0	90.0	113.8	147.3	154.6	149.8
W(t)	1103.6	1080.2	1046.1	1020.0	1004.7	1031.0	1068.9	1132.2	1201.0	1214.4	1209.2	1146.5	1105.1	1082.0	1048.1	1022.0	1006.9	1033.1	1070.9	1133.9
Y(t)	1065.7	1045.0	1014.5	990.9	977.0	1000.8	1034.9	1090.8	1149.7	1161.0	1156.6	1103.2	1067.0	1046.6	1016.3	992.7	979.0	1002.8	1036.7	1092.2
Sw(t)	1018.5	993.9	974.7	938.9	912.8	916.6	943.8	997.3	1050.6	1060.0	1040.0	1023.9	1019.7	995.3	976.2	940.5	914.3	917.9	944.8	998.3
Ro(t)	31.2	29.0	26.0	24.0	22.8	24.8	28.0	34.1	42.2	44.0	43.3	35.7	31.3	29.1	26.2	24.1	23.0	25.0	28.2	34.3
Rg(t)	6.7	6.2	5.6	5.1	4.9	5.3	6.0	7.3	9.1	9.4	9.3	7.7	6.7	6.3	5.6	5.2	4.9	5.4	6.0	7.4
Sg(t)	4793.2	4792.2	4790.6	4788.5	4786.2	4784.3	4783.1	4783.3	4785.1	4787.4	4789.5	4789.9	4789.4	4788.5	4786.9	4784.9	4782.6	4780.8	4779.6	4779.8
Qg(t)	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2
Q(t)	38.4	36.2	33.3	31.2	30.0	32.0	35.2	41.3	49.4	51.2	50.5	42.9	38.5	36.4	33.4	31.3	30.2	32.2	35.3	41.5
E(t)	47.2	51.1	39.8	52.0	64.2	84.2	91.1	93.4	99.1	100.9	116.6	79.3	47.3	51.2	40.1	52.3	64.7	84.9	91.9	94.0

Appendix D (Continued)

Table D13. (Continued)

	2020												2021							
	601	602	603	604	605	606	607	608	609	610	611	612	613	614	615	616	617	618	619	620
	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A
P(t)	204.4	164.6	149.8	107.2	81.9	62.9	53.4	46.4	67.0	119.5	153.7	189.8	205.1	165.3	150.5	107.8	82.5	63.5	53.9	46.9
PE(t)	150.8	152.2	177.4	124.7	75.7	83.7	67.4	90.4	114.5	148.3	155.6	150.5	151.5	153.0	177.9	125.2	75.8	83.9	67.8	90.7
W(t)	1202.6	1216.0	1210.6	1147.9	1106.6	1083.8	1050.1	1024.1	1009.1	1035.3	1072.8	1135.5	1204.3	1217.6	1212.0	1149.4	1108.1	1085.6	1052.1	1026.1
Y(t)	1151.1	1162.3	1157.8	1104.4	1068.4	1048.2	1018.1	994.6	981.0	1004.8	1038.4	1093.7	1152.5	1163.6	1158.9	1105.7	1069.7	1049.7	1019.9	996.4
Sw(t)	1051.4	1060.8	1040.8	1024.7	1020.9	996.8	977.7	942.0	915.8	919.1	945.8	999.2	1052.2	1061.5	1041.5	1025.6	1022.1	998.2	979.2	943.6
Ro(t)	42.4	44.2	43.5	35.8	31.5	29.3	26.4	24.3	23.2	25.2	28.3	34.5	42.6	44.4	43.7	36.0	31.6	29.5	26.5	24.4
Rg(t)	9.1	9.5	9.3	7.7	6.8	6.3	5.7	5.2	5.0	5.4	6.1	7.4	9.2	9.5	9.4	7.7	6.8	6.3	5.7	5.2
Sg(t)	4781.7	4784.0	4786.1	4786.6	4786.2	4785.3	4783.7	4781.7	4779.5	4777.7	4776.6	4776.8	4778.8	4781.1	4783.3	4783.8	4783.4	4782.6	4781.1	4779.1
Qg(t)	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2
Q(t)	49.6	51.4	50.7	43.0	38.7	36.5	33.6	31.5	30.3	32.4	35.5	41.6	49.8	51.6	50.9	43.2	38.8	36.7	33.7	31.6
E(t)	99.7	101.5	117.0	79.7	47.5	51.4	40.4	52.5	65.2	85.6	92.7	94.5	100.2	102.1	117.4	80.1	47.6	51.6	40.7	52.8

	2021				2022												2023			
	621	622	623	624	625	626	627	628	629	630	631	632	633	634	635	636	637	638	639	640
	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A
P(t)	67.7	120.2	154.4	190.5	205.8	166.1	151.2	108.5	83.1	64.1	54.5	47.5	68.3	120.9	155.1	191.2	206.5	166.9	151.9	109.2
PE(t)	115.1	149.4	156.7	151.2	152.3	153.7	178.4	125.7	75.9	84.1	68.2	91.0	115.8	150.4	157.9	151.9	153.0	154.5	178.9	126.2
W(t)	1011.3	1037.5	1074.8	1137.2	1205.9	1219.1	1213.4	1150.8	1109.6	1087.3	1054.1	1028.2	1013.5	1039.7	1076.7	1138.8	1207.5	1220.7	1214.8	1152.2
Y(t)	982.9	1006.7	1040.2	1095.1	1153.8	1164.9	1160.1	1106.9	1071.0	1051.3	1021.7	998.3	984.9	1008.7	1041.9	1096.5	1155.2	1166.2	1161.3	1108.1
Sw(t)	917.3	920.3	946.7	1000.1	1053.0	1062.2	1042.3	1026.4	1023.2	999.6	980.7	945.2	918.8	921.6	947.6	1001.0	1053.8	1062.8	1043.0	1027.2
Ro(t)	23.3	25.3	28.5	34.6	42.9	44.7	43.9	36.1	31.8	29.6	26.7	24.6	23.5	25.5	28.7	34.8	43.1	44.9	44.1	36.3
Rg(t)	5.0	5.4	6.1	7.4	9.2	9.6	9.4	7.8	6.8	6.4	5.7	5.3	5.0	5.5	6.2	7.5	9.2	9.6	9.5	7.8
Sg(t)	4776.9	4775.2	4774.1	4774.4	4776.4	4778.8	4781.0	4781.6	4781.2	4780.4	4778.9	4777.0	4774.8	4773.1	4772.1	4772.4	4774.5	4776.9	4779.2	4779.8
Qg(t)	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2
Q(t)	30.5	32.5	35.7	41.8	50.1	51.8	51.1	43.3	39.0	36.8	33.9	31.8	30.7	32.7	35.9	42.0	50.3	52.1	51.2	43.5
E(t)	65.7	86.4	93.4	95.0	100.8	102.7	117.9	80.5	47.7	51.7	41.0	53.1	66.2	87.1	94.2	95.6	101.4	103.3	118.3	80.9

Appendix D (Continued)

Table D13. (Continued)

	2023 641 M	642 J	643 J	644 A	645 S	646 O	647 N	648 D	2024 649 J	650 F	651 M	652 A	653 M	654 J	655 J	656 A	657 S	658 O	659 N	660 D
P(t)	83.8	64.7	55.1	48.1	68.9	121.6	155.9	191.9	207.3	167.7	152.6	109.9	84.4	65.4	55.7	48.6	69.6	122.3	156.6	192.6
PE(t)	76.0	84.2	68.6	91.4	116.4	151.5	159.0	152.6	153.8	155.3	179.4	126.7	76.2	84.4	69.0	91.7	117.1	152.6	160.1	153.3
W(t)	1111.0	1089.1	1056.1	1030.2	1015.7	1041.9	1078.6	1140.5	1209.1	1222.2	1216.1	1153.6	1112.5	1090.9	1058.1	1032.3	1017.9	1044.0	1080.6	1142.1
Y(t)	1072.2	1052.9	1023.4	1000.1	986.9	1010.7	1043.6	1098.0	1156.5	1167.4	1162.4	1109.3	1073.5	1054.5	1025.2	1002.0	989.0	1012.6	1045.3	1099.4
Sw(t)	1024.4	1001.0	982.2	946.7	920.3	922.8	948.6	1001.8	1054.5	1063.5	1043.7	1028.0	1025.5	1002.4	983.6	948.3	921.8	924.0	949.5	1002.7
Ro(t)	31.9	29.8	26.9	24.8	23.6	25.7	28.8	35.0	43.3	45.1	44.2	36.4	32.1	30.0	27.0	24.9	23.8	25.9	29.0	35.2
Rg(t)	6.9	6.4	5.8	5.3	5.1	5.5	6.2	7.5	9.3	9.7	9.5	7.8	6.9	6.4	5.8	5.3	5.1	5.6	6.2	7.5
Sg(t)	4779.4	4778.6	4777.2	4775.3	4773.2	4771.6	4770.6	4770.9	4773.0	4775.5	4777.8	4778.5	4778.2	4777.4	4776.0	4774.2	4772.1	4770.5	4769.5	4769.9
Qg(t)	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2
Q(t)	39.1	37.0	34.1	31.9	30.8	32.9	36.0	42.2	50.5	52.3	51.4	43.6	39.3	37.2	34.2	32.1	31.0	33.0	36.2	42.3
E(t)	47.9	51.9	41.3	53.4	66.7	87.9	95.0	96.1	102.0	103.9	118.7	81.3	48.0	52.1	41.6	53.7	67.2	88.7	95.8	96.7

	2025 661 J	662 F	663 M	664 A	665 M	666 J	667 J	668 A	669 S	670 O	671 N	672 D	2026 673 J	674 F	675 M	676 A	677 M	678 J	679 J	680 A
P(t)	208.0	168.5	153.3	110.6	85.1	66.0	56.3	49.2	70.2	122.9	157.3	193.3	208.7	169.2	154.0	111.3	85.7	66.7	56.9	49.8
PE(t)	154.5	156.0	179.9	127.2	76.3	84.5	69.4	92.0	117.8	153.7	161.3	154.0	155.3	156.8	180.4	127.7	76.4	84.7	69.8	92.4
W(t)	1210.7	1223.7	1217.5	1155.0	1113.9	1092.7	1060.1	1034.3	1020.1	1046.2	1082.5	1143.7	1212.2	1225.2	1218.8	1156.4	1115.4	1094.5	1062.1	1036.4
Y(t)	1157.8	1168.7	1163.5	1110.5	1074.8	1056.1	1027.0	1003.8	991.0	1014.6	1047.0	1100.8	1159.1	1169.9	1164.6	1111.7	1076.1	1057.7	1028.8	1005.7
Sw(t)	1055.2	1064.1	1044.4	1028.8	1026.7	1003.8	985.1	949.9	923.3	925.1	950.3	1003.5	1055.9	1064.8	1045.0	1029.6	1027.8	1005.2	986.6	951.4
Ro(t)	43.5	45.3	44.4	36.6	32.2	30.1	27.2	25.1	24.0	26.1	29.2	35.3	43.7	45.5	44.6	36.8	32.4	30.3	27.4	25.3
Rg(t)	9.3	9.7	9.5	7.9	6.9	6.5	5.8	5.4	5.1	5.6	6.3	7.6	9.4	9.8	9.6	7.9	6.9	6.5	5.9	5.4
Sg(t)	4772.1	4774.6	4776.9	4777.6	4777.3	4776.6	4775.3	4773.5	4771.4	4769.9	4769.0	4769.4	4771.6	4774.1	4776.5	4777.2	4777.0	4776.3	4775.0	4773.2
Qg(t)	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2
Q(t)	50.7	52.5	51.6	43.8	39.4	37.3	34.4	32.3	31.2	33.2	36.4	42.5	50.9	52.7	51.8	44.0	39.5	37.5	34.6	32.4
E(t)	102.6	104.5	119.2	81.7	48.1	52.3	41.9	54.0	67.7	89.5	96.7	97.2	103.2	105.2	119.6	82.1	48.2	52.5	42.2	54.3

Appendix D (Continued)

Table D13. (Continued)

	2026				2027												2028			
	681	682	683	684	685	686	687	688	689	690	691	692	693	694	695	696	697	698	699	700
	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A
P(t)	70.9	123.6	158.1	194.1	209.4	170.0	154.8	112.0	86.4	67.3	57.5	50.4	71.5	124.3	158.8	194.8	210.2	170.8	155.5	112.8
PE(t)	118.5	154.8	162.5	154.7	156.1	157.6	180.9	128.2	76.5	84.9	70.2	92.7	119.2	155.9	163.7	155.5	156.8	158.4	181.5	128.7
W(t)	1022.3	1048.4	1084.4	1145.3	1213.8	1226.6	1220.1	1157.7	1116.8	1096.3	1064.1	1038.4	1024.5	1050.6	1086.3	1146.8	1215.3	1228.1	1221.4	1159.1
Y(t)	993.0	1016.6	1048.7	1102.1	1160.4	1171.1	1165.7	1112.9	1077.3	1059.3	1030.6	1007.6	995.0	1018.5	1050.4	1103.5	1161.7	1172.3	1166.8	1114.1
Sw(t)	924.8	926.3	951.2	1004.3	1056.6	1065.4	1045.7	1030.4	1029.0	1006.6	988.1	953.0	926.3	927.5	952.1	1005.1	1057.3	1065.9	1046.3	1031.2
Ro(t)	24.2	26.2	29.4	35.5	43.9	45.7	44.8	36.9	32.5	30.5	27.6	25.4	24.3	26.4	29.5	35.7	44.1	45.9	45.0	37.1
Rg(t)	5.2	5.6	6.3	7.6	9.4	9.8	9.6	7.9	7.0	6.5	5.9	5.5	5.2	5.7	6.3	7.7	9.5	9.9	9.7	8.0
Sg(t)	4771.2	4769.7	4768.8	4769.3	4771.5	4774.1	4776.6	4777.3	4777.1	4776.5	4775.2	4773.5	4771.5	4770.0	4769.2	4769.6	4771.9	4774.6	4777.1	4777.8
Qg(t)	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2
Q(t)	31.3	33.4	36.5	42.7	51.1	52.9	52.0	44.1	39.7	37.7	34.7	32.6	31.5	33.6	36.7	42.9	51.3	53.1	52.2	44.3
E(t)	68.2	90.2	97.5	97.8	103.8	105.8	120.0	82.5	48.4	52.6	42.6	54.6	68.7	91.1	98.3	98.4	104.4	106.4	120.5	82.9

	2028								2029											
	701	702	703	704	705	706	707	708	709	710	711	712	713	714	715	716	717	718	719	720
	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
P(t)	87.1	68.0	58.1	51.0	72.2	125.0	159.5	195.5	210.9	171.6	156.2	113.5	87.7	68.7	58.7	51.6	72.9	125.7	160.3	196.2
PE(t)	76.6	85.0	70.6	93.0	119.9	157.1	164.9	156.2	157.6	159.3	182.0	129.3	76.7	85.2	71.1	93.4	120.6	158.3	166.1	157.0
W(t)	1118.2	1098.1	1066.1	1040.5	1026.8	1052.8	1088.2	1148.4	1216.8	1229.6	1222.7	1160.4	1119.7	1099.8	1068.1	1042.6	1029.0	1055.0	1090.1	1149.9
Y(t)	1078.6	1060.8	1032.4	1009.4	997.0	1020.5	1052.1	1104.8	1163.0	1173.5	1167.9	1115.2	1079.8	1062.4	1034.2	1011.3	999.1	1022.5	1053.8	1106.2
Sw(t)	1030.1	1008.0	989.6	954.6	927.8	928.6	952.9	1005.9	1057.9	1066.5	1046.9	1031.9	1031.2	1009.4	991.0	956.1	929.3	929.8	953.7	1006.7
Ro(t)	32.7	30.7	27.7	25.6	24.5	26.6	29.7	35.9	44.3	46.1	45.1	37.2	32.8	30.8	27.9	25.8	24.7	26.8	29.9	36.0
Rg(t)	7.0	6.6	6.0	5.5	5.3	5.7	6.4	7.7	9.5	9.9	9.7	8.0	7.0	6.6	6.0	5.5	5.3	5.7	6.4	7.7
Sg(t)	4777.7	4777.0	4775.8	4774.1	4772.2	4770.7	4769.9	4770.4	4772.8	4775.5	4778.0	4778.8	4778.6	4778.1	4776.9	4775.2	4773.3	4771.9	4771.1	4771.7
Qg(t)	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2
Q(t)	39.8	37.8	34.9	32.8	31.7	33.8	36.9	43.0	51.5	53.3	52.3	44.4	40.0	38.0	35.1	32.9	31.9	34.0	37.1	43.2
E(t)	48.5	52.8	42.9	54.9	69.3	91.9	99.2	98.9	105.0	107.0	120.9	83.3	48.6	53.0	43.2	55.2	69.8	92.7	100.1	99.5

Appendix D (Continued)

Table D13. (Continued)

	2030												2031							
	721	722	723	724	725	726	727	728	729	730	731	732	733	734	735	736	737	738	739	740
	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A
P(t)	211.6	172.4	156.9	114.2	88.4	69.3	59.3	52.2	73.6	126.4	161.0	197.0	212.4	173.2	157.6	114.9	89.1	70.0	60.0	52.8
PE(t)	158.4	160.1	182.5	129.8	76.9	85.4	71.5	93.7	121.3	159.4	167.4	157.7	159.2	160.9	183.1	130.3	77.0	85.5	71.9	94.1
W(t)	1218.3	1207.7	1183.7	1110.2	1061.7	1035.7	999.5	970.3	955.0	980.7	1016.2	1076.1	1143.3	1153.9	1145.2	1082.9	1041.0	1019.4	986.7	959.9
Y(t)	1140.3	1132.1	1113.2	1053.4	1012.7	990.4	959.0	933.3	919.8	942.5	973.6	1024.9	1080.7	1089.3	1082.2	1030.6	995.0	976.3	947.7	924.1
Sw(t)	1035.3	1026.8	996.0	973.3	966.3	940.2	918.1	881.4	854.2	855.2	879.1	930.9	980.7	987.5	967.9	951.9	949.3	926.7	907.1	872.6
Ro(t)	68.1	66.1	61.6	49.5	42.8	39.5	35.4	32.3	30.8	33.3	37.2	44.7	54.7	56.4	55.0	45.6	40.2	37.6	34.0	31.2
Rg(t)	9.9	9.6	8.9	7.2	6.2	5.7	5.1	4.7	4.5	4.8	5.4	6.5	7.9	8.2	8.0	6.6	5.8	5.5	4.9	4.5
Sg(t)	4773.9	4775.8	4777.1	4776.6	4775.2	4773.3	4770.7	4767.8	4764.6	4761.8	4759.5	4758.4	4758.7	4759.2	4759.6	4758.6	4756.8	4754.6	4751.9	4748.8
Qg(t)	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6
Q(t)	75.8	73.7	69.3	57.2	50.5	47.2	43.0	39.9	38.4	41.0	44.9	52.4	62.3	64.1	62.6	53.3	47.8	45.2	41.6	38.9
E(t)	105.0	105.3	117.2	80.1	46.4	50.2	40.9	51.8	65.6	87.3	94.5	94.0	100.0	101.8	114.3	78.7	45.6	49.6	40.7	51.5
	2031				2032												2033			
	741	742	743	744	745	746	747	748	749	750	751	752	753	754	755	756	757	758	759	760
	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A
P(t)	74.3	127.2	161.8	197.7	213.1	174.0	158.4	115.7	89.8	70.7	60.6	53.4	74.9	127.9	162.6	198.4	213.9	174.9	159.1	116.4
PE(t)	122.0	160.6	168.7	158.5	160.1	161.8	183.6	130.9	77.1	85.7	72.4	94.5	122.8	161.8	169.9	159.3	160.9	162.6	184.1	131.4
W(t)	946.8	974.2	1011.2	1072.2	1140.6	1152.3	1144.2	1082.6	1041.1	1020.1	987.8	961.2	948.4	975.9	1012.7	1073.4	1141.9	1153.5	1145.3	1083.8
Y(t)	912.5	936.8	969.2	1021.6	1078.5	1088.0	1081.4	1030.3	995.1	976.9	948.8	925.3	913.9	938.3	970.5	1022.6	1079.5	1089.0	1082.3	1031.4
Sw(t)	847.1	849.4	874.5	927.5	978.2	985.8	966.9	951.3	949.4	927.2	907.8	873.5	848.0	850.1	875.0	928.0	978.7	986.2	967.4	952.0
Ro(t)	30.0	32.7	36.7	44.2	54.2	56.2	54.8	45.6	40.2	37.7	34.1	31.4	30.1	32.9	36.8	44.4	54.4	56.4	55.0	45.8
Rg(t)	4.3	4.7	5.3	6.4	7.9	8.1	8.0	6.6	5.8	5.5	4.9	4.6	4.4	4.8	5.3	6.4	7.9	8.2	8.0	6.6
Sg(t)	4745.5	4742.7	4740.4	4739.2	4739.5	4740.0	4740.4	4739.4	4737.6	4735.5	4732.8	4729.8	4726.6	4723.8	4721.5	4720.4	4720.7	4721.3	4721.7	4720.8
Qg(t)	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6
Q(t)	37.6	40.3	44.3	51.8	61.9	63.8	62.4	53.2	47.8	45.3	41.7	39.0	37.7	40.4	44.4	51.9	62.0	63.9	62.6	53.3
E(t)	65.4	87.4	94.7	94.1	100.3	102.2	114.5	79.0	45.7	49.7	40.9	51.8	65.9	88.2	95.5	94.6	100.9	102.8	114.9	79.4

Appendix D (Continued)

Table D13. (Continued)

	2033 761 M	762 J	763 J	764 A	765 S	766 O	767 N	768 D	2034 769 J	770 F	771 M	772 A	773 M	774 J	775 J	776 A	777 S	778 O	779 N	780 D
P(t)	90.5	71.4	61.3	54.0	75.6	128.6	163.3	199.2	214.6	175.7	159.8	117.2	91.2	72.1	61.9	54.7	76.4	129.3	164.1	199.9
PE(t)	77.2	85.9	72.8	94.8	123.5	163.1	171.2	160.0	161.7	163.5	184.7	131.9	77.3	86.0	73.3	95.2	124.3	164.3	172.6	160.8
W(t)	1042.5	1021.8	989.8	963.2	950.7	978.1	1014.5	1074.9	1143.3	1154.9	1146.5	1085.1	1043.9	1023.6	991.8	965.3	952.9	980.2	1016.4	1076.4
Y(t)	996.2	978.4	950.5	927.1	915.9	940.2	972.1	1023.9	1080.7	1090.1	1083.3	1032.5	997.4	980.0	952.3	928.9	917.9	942.1	973.7	1025.1
Sw(t)	950.4	928.5	909.2	875.0	849.5	851.2	875.7	928.7	979.2	986.7	968.0	952.7	951.5	929.9	910.7	876.5	850.9	852.3	876.5	929.4
Ro(t)	40.4	37.9	34.3	31.6	30.3	33.1	37.1	44.6	54.7	56.6	55.2	46.0	40.5	38.1	34.5	31.8	30.6	33.3	37.3	44.8
Rg(t)	5.9	5.5	5.0	4.6	4.4	4.8	5.4	6.5	7.9	8.2	8.0	6.7	5.9	5.5	5.0	4.6	4.4	4.8	5.4	6.5
Sg(t)	4719.1	4717.0	4714.4	4711.4	4708.3	4705.5	4703.3	4702.3	4702.7	4703.3	4703.8	4702.9	4701.2	4699.2	4696.7	4693.8	4690.7	4688.0	4685.9	4684.9
Qg(t)	7.6	7.6	7.6	7.6	7.6	7.6	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5
Q(t)	47.9	45.5	41.9	39.1	37.9	40.6	44.6	52.1	62.2	64.1	62.8	53.5	48.1	45.6	42.1	39.3	38.1	40.8	44.8	52.3
E(t)	45.8	49.9	41.3	52.1	66.4	89.0	96.4	95.2	101.5	103.4	115.4	79.8	45.9	50.1	41.6	52.4	67.0	89.8	97.2	95.7

	2035 781 J	782 F	783 M	784 A	785 M	786 J	787 J	788 A	789 S	790 O	791 N	792 D	2036 793 J	794 F	795 M	796 A	797 M	798 J	799 J	800 A
P(t)	215.4	176.5	160.6	117.9	91.9	72.8	62.6	55.3	77.1	130.0	164.8	200.7	216.1	177.3	161.3	118.7	92.6	73.5	63.2	56.0
PE(t)	162.6	164.3	185.2	132.5	77.5	86.2	73.7	95.6	125.1	165.6	173.9	161.6	163.4	165.2	185.8	133.1	77.6	86.4	74.2	95.9
W(t)	1144.8	1156.3	1147.8	1086.4	1045.3	1025.4	993.8	967.4	955.2	982.4	1018.2	1077.9	1146.2	1157.7	1149.0	1087.7	1046.7	1027.2	995.9	969.5
Y(t)	1081.9	1091.2	1084.3	1033.6	998.6	981.5	954.0	930.8	919.9	944.0	975.3	1026.4	1083.0	1092.3	1085.3	1034.7	999.8	983.0	955.8	932.6
Sw(t)	979.8	987.2	968.5	953.4	952.6	931.2	912.1	878.1	852.4	853.4	877.2	930.1	980.3	987.7	969.1	954.1	953.6	932.6	913.5	879.6
Ro(t)	54.9	56.8	55.4	46.1	40.7	38.3	34.7	32.0	30.8	33.5	37.5	45.0	55.1	57.1	55.6	46.3	40.9	38.5	35.0	32.2
Rg(t)	8.0	8.2	8.0	6.7	5.9	5.6	5.0	4.6	4.5	4.9	5.4	6.5	8.0	8.3	8.1	6.7	5.9	5.6	5.1	4.7
Sg(t)	4685.3	4686.0	4686.6	4685.7	4684.1	4682.2	4679.7	4676.8	4673.8	4671.2	4669.1	4668.1	4668.7	4669.4	4670.0	4669.2	4667.7	4665.8	4663.4	4660.6
Qg(t)	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5
Q(t)	62.4	64.3	62.9	53.7	48.2	45.8	42.3	39.5	38.3	41.0	45.0	52.5	62.6	64.5	63.1	53.8	48.4	46.0	42.5	39.7
E(t)	102.1	104.0	115.8	80.2	46.1	50.3	41.9	52.7	67.5	90.6	98.1	96.3	102.7	104.7	116.2	80.6	46.2	50.4	42.3	53.0

Appendix D (Continued)

Table D13. (Continued)

	2036 801 S	802 O	803 N	804 D	2037 805 J	806 F	807 M	808 A	809 M	810 J	811 J	812 A	813 S	814 O	815 N	816 D	2038 817 J	818 F	819 M	820 A
P(t)	77.8	130.8	165.6	201.4	216.9	178.2	162.1	119.4	93.3	74.2	63.9	56.6	78.5	131.5	166.4	202.2	217.6	179.0	162.8	120.2
PE(t)	125.8	166.9	175.3	162.4	164.3	166.1	186.3	133.6	77.7	86.6	74.7	96.3	126.6	168.2	176.6	163.3	165.2	167.0	186.9	134.2
W(t)	957.4	984.6	1020.1	1079.3	1147.6	1159.0	1150.2	1089.0	1048.1	1028.9	997.9	971.6	959.7	986.8	1021.9	1080.8	1149.0	1160.4	1151.3	1090.3
Y(t)	921.9	946.0	976.9	1027.6	1084.2	1093.4	1086.3	1035.8	1001.0	984.6	957.6	934.5	924.0	947.9	978.5	1028.8	1085.3	1094.5	1087.2	1036.9
Sw(t)	853.9	854.5	877.9	930.7	980.9	988.1	969.6	954.8	954.7	934.0	915.0	881.2	855.3	855.5	878.6	931.4	981.4	988.5	970.1	955.4
Ro(t)	31.0	33.8	37.7	45.2	55.4	57.3	55.8	46.5	41.1	38.7	35.2	32.4	31.2	34.0	37.9	45.4	55.6	57.5	56.0	46.7
Rg(t)	4.5	4.9	5.5	6.6	8.0	8.3	8.1	6.7	6.0	5.6	5.1	4.7	4.5	4.9	5.5	6.6	8.1	8.3	8.1	6.8
Sg(t)	4657.6	4655.0	4653.0	4652.1	4652.7	4653.5	4654.2	4653.4	4651.9	4650.1	4647.7	4645.0	4642.1	4639.5	4637.6	4636.7	4637.4	4638.3	4639.0	4638.3
Qg(t)	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4
Q(t)	38.5	41.2	45.2	52.6	62.8	64.7	63.3	54.0	48.5	46.2	42.7	39.9	38.7	41.4	45.3	52.8	63.1	64.9	63.4	54.1
E(t)	68.1	91.5	99.0	96.9	103.3	105.3	116.6	81.0	46.3	50.6	42.6	53.3	68.6	92.4	99.9	97.5	104.0	106.0	117.1	81.5

	2038 821 M	822 J	823 J	824 A	825 S	826 O	827 N	828 D	2039 829 J	830 F	831 M	832 A	833 M	834 J	835 J	836 A	837 S	838 O	839 N	840 D
P(t)	94.0	75.0	64.6	57.3	79.2	132.2	167.2	202.9	222.1	181.8	167.8	125.2	100.4	81.6	72.5	65.8	85.7	137.7	171.4	207.5
PE(t)	77.8	86.7	75.1	96.7	127.4	169.5	178.0	164.1	168.5	167.9	188.8	135.7	78.4	87.1	77.6	98.3	129.8	175.1	182.5	167.2
W(t)	1049.4	1030.7	999.9	973.7	962.0	989.0	1023.7	1082.2	1154.1	1164.9	1159.1	1099.8	1062.3	1047.5	1021.4	998.6	988.1	1014.5	1045.1	1100.9
Y(t)	1002.2	986.1	959.4	936.3	926.0	949.8	980.1	1030.1	1089.5	1098.2	1093.5	1044.8	1013.2	1000.6	978.0	958.2	949.1	972.1	998.5	1045.7
Sw(t)	955.8	935.3	916.4	882.7	856.8	856.6	879.3	932.0	983.1	991.3	974.6	961.9	965.9	948.8	932.8	902.5	876.8	873.6	893.3	944.3
Ro(t)	41.2	38.9	35.4	32.6	31.4	34.2	38.1	45.6	56.5	58.3	57.3	48.0	42.9	41.0	37.8	35.3	34.1	37.0	40.7	48.2
Rg(t)	6.0	5.7	5.1	4.7	4.6	5.0	5.5	6.6	8.2	8.5	8.3	7.0	6.2	5.9	5.5	5.1	5.0	5.4	5.9	7.0
Sg(t)	4636.8	4635.0	4632.7	4630.0	4627.2	4624.7	4622.8	4622.0	4622.8	4623.8	4624.7	4624.3	4623.1	4621.6	4619.7	4617.4	4615.0	4612.9	4611.4	4611.0
Qg(t)	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4
Q(t)	48.7	46.4	42.9	40.1	38.9	41.7	45.5	53.0	63.9	65.7	64.7	55.5	50.3	48.4	45.3	42.7	41.5	44.5	48.1	55.6
E(t)	46.4	50.8	43.0	53.6	69.2	93.2	100.8	98.1	106.4	106.8	118.9	83.0	47.3	51.7	45.2	55.7	72.2	98.4	105.1	101.4

Appendix D (Continued)

Table D13. (Continued)

	2040 841 J	842 F	843 M	844 A	845 M	846 J	847 J	848 A	849 S	850 O	851 N	852 D	2041 853 J	854 F	855 M	856 A	857 M	858 J	859 J	860 A
P(t)	222.9	182.7	168.6	126.0	101.2	82.4	73.3	66.6	86.5	138.4	172.2	208.3	222.5	182.3	168.2	125.6	100.8	82.0	72.9	66.1
PE(t)	169.5	168.8	189.4	136.3	78.5	87.2	78.1	98.7	130.7	176.5	183.9	168.1	170.7	170.2	190.8	137.2	78.9	87.7	78.5	99.3
W(t)	1167.2	1174.7	1166.4	1105.5	1067.1	1052.1	1025.8	1002.7	992.1	1018.0	1047.9	1103.0	1167.9	1174.1	1164.7	1103.0	1064.2	1049.2	1022.7	999.5
Y(t)	1100.0	1106.0	1099.4	1049.6	1017.3	1004.5	981.9	961.8	952.5	975.2	1000.9	1047.5	1100.6	1105.5	1098.0	1047.5	1014.8	1002.0	979.2	959.0
Sw(t)	992.1	997.9	979.5	965.9	969.7	952.5	936.2	905.7	879.6	875.6	894.7	945.4	991.8	996.6	977.4	963.4	967.2	949.8	933.4	902.7
Ro(t)	58.7	60.0	58.5	48.9	43.5	41.6	38.4	35.7	34.6	37.5	41.0	48.5	58.8	59.9	58.3	48.5	43.1	41.2	38.0	35.4
Rg(t)	8.5	8.7	8.5	7.1	6.3	6.0	5.6	5.2	5.0	5.4	6.0	7.0	8.5	8.7	8.5	7.0	6.3	6.0	5.5	5.1
Sg(t)	4612.1	4613.4	4614.5	4614.2	4613.1	4611.8	4609.9	4607.7	4605.3	4603.4	4602.0	4601.6	4602.8	4604.1	4605.1	4604.8	4603.6	4602.2	4600.4	4598.1
Qg(t)	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4
Q(t)	66.1	67.4	65.9	56.3	50.9	49.0	45.8	43.1	42.0	44.8	48.4	55.9	66.2	67.3	65.6	55.9	50.5	48.6	45.4	42.7
E(t)	108.0	108.2	119.9	83.7	47.5	52.0	45.7	56.2	72.9	99.5	106.2	102.0	108.8	108.9	120.6	84.1	47.6	52.2	45.8	56.3

	2041 861 S	862 O	863 N	864 D	2042 865 J	866 F	867 M	868 A	869 M	870 J	871 J	872 A	873 S	874 O	875 N	876 D	2043 877 J	878 F	879 M	880 A
P(t)	86.0	138.1	171.8	207.9	222.1	181.8	167.8	125.2	100.4	81.6	72.4	65.7	85.6	137.7	171.4	207.5	221.7	181.4	167.4	124.8
PE(t)	131.6	177.9	185.4	169.3	172.0	171.6	192.3	138.2	79.3	88.2	78.9	99.8	132.5	179.2	186.9	170.6	173.3	173.0	193.8	139.1
W(t)	988.7	1014.4	1044.0	1098.8	1163.7	1169.8	1160.5	1098.7	1059.9	1045.0	1018.6	995.5	984.7	1010.3	1039.6	1094.3	1159.2	1165.4	1156.0	1094.2
Y(t)	949.6	972.0	997.5	1044.0	1097.2	1102.1	1094.6	1043.9	1011.2	998.4	975.6	955.5	946.0	968.4	993.8	1040.2	1093.6	1098.6	1091.0	1040.1
Sw(t)	876.4	872.1	890.9	941.6	988.0	992.7	973.5	959.5	963.5	946.2	929.8	899.1	872.6	868.2	886.8	937.5	984.0	988.6	969.4	955.5
Ro(t)	34.2	37.0	40.6	47.9	58.1	59.1	57.5	47.9	42.6	40.7	37.5	34.9	33.8	36.6	40.0	47.2	57.3	58.4	56.8	47.2
Rg(t)	5.0	5.4	5.9	6.9	8.4	8.6	8.3	6.9	6.2	5.9	5.4	5.1	4.9	5.3	5.8	6.9	8.3	8.5	8.2	6.9
Sg(t)	4595.7	4593.7	4592.2	4591.8	4592.9	4594.1	4595.0	4594.6	4593.4	4591.9	4590.0	4587.7	4585.3	4583.2	4581.7	4581.2	4582.1	4583.3	4584.1	4583.6
Qg(t)	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4
Q(t)	41.6	44.4	47.9	55.3	65.4	66.5	64.9	55.2	50.0	48.1	44.9	42.3	41.1	43.9	47.4	54.6	64.7	65.7	64.1	54.6
E(t)	73.2	99.9	106.6	102.4	109.2	109.4	121.1	84.3	47.7	52.3	45.8	56.4	73.4	100.2	107.0	102.8	109.6	109.9	121.6	84.6

Appendix D (Continued)

Table D13. (Continued)

	2043								2044											
	881	882	883	884	885	886	887	888	889	890	891	892	893	894	895	896	897	898	899	900
	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
P(t)	100.0	81.1	72.0	65.3	85.2	137.3	171.0	207.2	221.4	181.0	167.0	124.4	99.6	80.7	71.6	64.8	84.8	136.9	170.6	206.8
PE(t)	79.7	88.7	79.3	100.4	133.4	180.6	188.4	171.9	174.6	174.4	195.4	140.1	80.1	89.2	79.7	101.0	134.3	182.0	189.9	173.2
W(t)	1055.5	1040.8	1014.4	991.4	980.6	1006.1	1035.2	1089.8	1154.7	1160.9	1151.5	1089.6	1051.0	1036.5	1010.2	987.3	976.5	1001.9	1030.8	1085.2
Y(t)	1007.4	994.8	972.0	951.9	942.4	964.8	990.0	1036.4	1089.9	1094.9	1087.4	1036.3	1003.6	991.1	968.4	948.3	938.8	961.1	986.2	1032.5
Sw(t)	959.6	942.4	926.2	895.4	868.8	864.2	882.6	933.3	979.9	984.5	965.3	951.4	955.8	938.6	922.4	891.7	865.0	860.1	878.4	929.1
Ro(t)	42.0	40.2	37.0	34.5	33.3	36.1	39.5	46.6	56.6	57.6	56.0	46.6	41.4	39.6	36.6	34.0	32.9	35.6	39.0	46.0
Rg(t)	6.1	5.8	5.4	5.0	4.8	5.2	5.7	6.8	8.2	8.4	8.1	6.8	6.0	5.8	5.3	4.9	4.8	5.2	5.7	6.7
Sg(t)	4582.4	4580.9	4578.9	4576.5	4574.0	4571.9	4570.3	4569.8	4570.6	4571.7	4572.5	4571.9	4570.6	4569.0	4566.9	4564.6	4562.0	4559.9	4558.2	4557.6
Qg(t)	7.4	7.4	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3
Q(t)	49.4	47.5	44.4	41.8	40.7	43.4	46.8	53.9	63.9	64.9	63.4	53.9	48.8	47.0	43.9	41.4	40.2	42.9	46.3	53.3
E(t)	47.8	52.4	45.9	56.5	73.6	100.6	107.4	103.1	110.0	110.4	122.1	84.9	47.8	52.5	45.9	56.6	73.8	100.9	107.8	103.4

	2045												2046							
	901	902	903	904	905	906	907	908	909	910	911	912	913	914	915	916	917	918	919	920
	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A
P(t)	221.0	180.6	166.6	124.0	99.2	80.3	71.2	64.4	84.4	136.5	170.2	206.4	220.6	180.2	166.3	123.6	98.8	79.9	70.8	64.0
PE(t)	175.9	175.8	196.9	141.1	80.5	89.7	80.1	101.6	135.2	183.4	191.4	174.5	177.2	177.3	198.5	142.1	80.9	90.2	80.5	102.2
W(t)	1150.1	1156.4	1147.0	1085.1	1046.5	1032.1	1006.0	983.1	972.3	997.6	1026.3	1080.5	1145.5	1151.8	1142.4	1080.4	1042.0	1027.8	1001.7	978.9
Y(t)	1086.2	1091.3	1083.7	1032.4	999.7	987.3	964.7	944.6	935.1	957.3	982.3	1028.6	1082.4	1087.6	1079.9	1028.5	995.8	983.6	960.9	940.9
Sw(t)	975.8	980.3	961.1	947.3	951.8	934.8	918.7	887.9	861.1	856.1	874.1	924.8	971.6	976.1	956.8	943.2	947.9	930.9	914.9	884.1
Ro(t)	55.8	56.8	55.3	45.9	40.9	39.1	36.1	33.6	32.5	35.2	38.4	45.3	55.0	56.1	54.5	45.3	40.3	38.6	35.6	33.2
Rg(t)	8.1	8.2	8.0	6.7	5.9	5.7	5.2	4.9	4.7	5.1	5.6	6.6	8.0	8.1	7.9	6.6	5.8	5.6	5.2	4.8
Sg(t)	4558.3	4559.3	4560.0	4559.3	4557.9	4556.3	4554.2	4551.8	4549.2	4547.0	4545.3	4544.6	4545.3	4546.1	4546.7	4546.0	4544.6	4542.9	4540.8	4538.3
Qg(t)	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3
Q(t)	63.1	64.1	62.6	53.3	48.2	46.4	43.4	40.9	39.8	42.5	45.7	52.6	62.3	63.4	61.8	52.6	47.6	45.9	42.9	40.4
E(t)	110.4	110.9	122.6	85.1	47.9	52.6	46.0	56.7	74.0	101.3	108.2	103.8	110.9	111.4	123.1	85.4	47.9	52.6	46.0	56.8

Appendix D (Continued)

Table D13. (Continued)

	2046 921 S	922 O	923 N	924 D	2047 925 J	926 F	927 M	928 A	929 M	930 J	931 J	932 A	933 S	934 O	935 N	936 D	2048 937 J	938 F	939 M	940 A
P(t)	83.9	136.1	169.9	206.0	220.2	179.8	165.9	123.2	98.4	79.5	70.4	63.6	83.5	135.7	169.5	205.7	219.9	179.3	165.5	122.8
PE(t)	136.2	184.8	193.0	175.8	178.6	178.8	200.1	143.2	81.3	90.8	80.9	102.8	137.2	186.3	194.6	177.2	180.0	180.3	201.8	144.2
W(t)	968.1	993.3	1021.8	1075.8	1140.8	1147.1	1137.7	1075.7	1037.3	1023.3	997.4	974.7	963.8	988.9	1017.2	1071.1	1136.1	1142.4	1133.0	1071.0
Y(t)	931.3	953.5	978.4	1024.7	1078.6	1083.8	1076.1	1024.6	991.8	979.7	957.1	937.2	927.6	949.7	974.5	1020.7	1074.8	1080.0	1072.3	1020.6
Sw(t)	857.1	851.9	869.8	920.5	967.4	971.9	952.5	938.9	943.9	927.0	911.1	880.3	853.2	847.8	865.4	916.2	963.1	967.5	948.2	934.7
Ro(t)	32.1	34.7	37.9	44.7	54.3	55.3	53.8	44.7	39.7	38.1	35.1	32.7	31.6	34.2	37.4	44.1	53.5	54.5	53.0	44.0
Rg(t)	4.7	5.0	5.5	6.5	7.9	8.0	7.8	6.5	5.8	5.5	5.1	4.7	4.6	5.0	5.4	6.4	7.8	7.9	7.7	6.4
Sg(t)	4535.7	4533.4	4531.6	4530.9	4531.5	4532.2	4532.7	4531.9	4530.4	4528.7	4526.5	4524.0	4521.4	4519.1	4517.2	4516.4	4516.9	4517.6	4518.0	4517.2
Qg(t)	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.2	7.2	7.2	7.2	7.3	7.2
Q(t)	39.3	42.0	45.2	52.0	61.5	62.6	61.1	51.9	47.0	45.3	42.4	40.0	38.9	41.5	44.6	51.3	60.8	61.8	60.3	51.3
E(t)	74.2	101.6	108.6	104.1	111.3	111.9	123.6	85.6	48.0	52.7	46.1	56.9	74.4	101.9	109.0	104.5	111.7	112.4	124.1	85.9

	2048 941 M	942 J	943 J	944 A	945 S	946 O	947 N	948 D	2049 949 J	950 F	951 M	952 A	953 M	954 J	955 J	956 A	957 S	958 O	959 N	960 D
P(t)	98.0	79.0	70.0	63.2	83.1	135.4	169.1	205.3	219.5	178.9	165.1	122.4	97.6	78.6	69.6	62.8	82.7	135.0	168.7	204.9
PE(t)	81.7	91.3	81.3	103.4	138.1	187.7	196.2	178.5	181.4	181.9	203.4	145.3	82.2	91.8	81.8	104.0	139.1	189.2	197.8	179.9
W(t)	1032.7	1018.8	993.0	970.4	959.5	984.5	1012.6	1066.3	1131.3	1137.7	1128.3	1066.2	1027.9	1014.3	988.5	966.0	955.1	980.1	1008.0	1061.5
Y(t)	987.8	975.8	953.3	933.4	923.8	945.9	970.5	1016.6	1070.9	1076.1	1068.4	1016.5	983.7	971.9	949.4	929.5	919.9	941.9	966.4	1012.5
Sw(t)	939.8	923.0	907.2	876.4	849.1	843.6	861.0	911.8	958.7	963.2	943.8	930.3	935.7	919.0	903.2	872.4	845.1	839.3	856.6	907.3
Ro(t)	39.2	37.5	34.7	32.3	31.2	33.8	36.8	43.4	52.8	53.8	52.3	43.4	38.6	37.0	34.2	31.9	30.8	33.3	36.3	42.8
Rg(t)	5.7	5.4	5.0	4.7	4.5	4.9	5.3	6.3	7.7	7.8	7.6	6.3	5.6	5.4	5.0	4.6	4.5	4.8	5.3	6.2
Sg(t)	4515.6	4513.8	4511.6	4509.0	4506.3	4504.0	4502.1	4501.2	4501.6	4502.2	4502.6	4501.6	4500.0	4498.2	4495.9	4493.3	4490.6	4488.2	4486.3	4485.3
Qg(t)	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2
Q(t)	46.4	44.8	41.9	39.5	38.4	41.0	44.1	50.6	60.0	61.0	59.5	50.6	45.8	44.2	41.4	39.1	38.0	40.5	43.5	50.0
E(t)	48.0	52.8	46.1	57.0	74.6	102.3	109.4	104.8	112.1	113.0	124.6	86.2	48.1	52.9	46.2	57.1	74.8	102.6	109.8	105.2

Appendix D (Continued)

Table D13. (Continued)

	2050 961 J	962 F	963 M	964 A	965 M	966 J	967 J	968 A	969 S	970 O	971 N	972 D
P(t)	219.1	178.5	164.7	122.0	97.2	78.2	69.2	62.4	82.3	134.6	168.3	204.5
PE(t)	182.8	183.5	205.1	146.4	82.6	92.4	82.2	104.6	140.1	190.8	199.5	181.3
W(t)	1126.5	1132.9	1123.5	1061.3	1023.2	1009.7	984.1	961.6	950.8	975.6	1003.3	1056.7
Y(t)	1066.9	1072.2	1064.4	1012.3	979.6	967.9	945.5	925.6	916.0	938.0	962.3	1008.4
Sw(t)	954.4	958.7	939.3	925.9	931.5	914.9	899.3	868.4	841.0	835.0	852.1	902.8
Ro(t)	52.0	53.0	51.6	42.8	38.1	36.5	33.7	31.4	30.4	32.8	35.8	42.2
Rg(t)	7.5	7.7	7.5	6.2	5.5	5.3	4.9	4.6	4.4	4.8	5.2	6.1
Sg(t)	4485.6	4486.1	4486.4	4485.4	4483.8	4481.9	4479.6	4476.9	4474.2	4471.7	4469.8	4468.7
Qg(t)	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2
Q(t)	59.2	60.2	58.8	50.0	45.2	43.7	40.9	38.6	37.5	40.0	43.0	49.3
E(t)	112.5	113.5	125.1	86.4	48.1	53.0	46.2	57.2	75.0	103.0	110.2	105.5