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Modeling and Visualizing Ecosystem Services for 3D Urban Planning

by

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List of Abbreviations

BT	Brightness temperature
CGA	Computer generated architecture
DEM	Digital elevation model
DSM	Digital surface model
EPA	Environmental Protection Agency
ES	Ecosystem services
GI	Green infrastructures
ICT	Information and communication technologies
LAI	Leaf area index
LST	Land surface temperature
MEA	Millennium Ecosystem Assessment
MILES	Managing Idaho's Landscapes for Ecosystem Services
NDVI	Normalized difference vegetation index
NDWI	Normalized difference water index
PCIs	Park Cool Islands
SCM	Surface change model
TOA	Top of atmospheric
TSP	Total suspended particulate
UAV	Unmanned aerial vehicle
UHI	Urban heat island
VR	Virtual reality

Modeling and Visualizing Ecosystem Services for 3D Urban Planning

Thesis Abstract – Idaho State University (2019)

This study integrated ecosystem services (ES) and 3D geo-visualization with urban design practices to inform future development in Pocatello, Idaho. Pocatello is a medium-sized city in southeastern Idaho that faces a range of challenges for sustainable future growth. It is important to understand what different urban designs can contribute to local ES. The objectives for this study were: building a 3D model for Pocatello Old Town, integrating key attributes in the model for planning and geodesign, visualizing in 3D using VR, and WebGL, and further, creating and analyzing the changes on local ES via future scenarios. The results showed that planting more trees and replacing impervious parking lots with green parking lots could reduce land surface temperature and improve air quality by removing particulate matter. With this approach, the decision makers in the City of Pocatello can analyze future scenarios both visually and statistically.

Key Words: procedural 3D modeling, geodesign, ecosystem services, urban heat island, GIS

Chapter 1 Introduction

The survival and sustainable development of human society is based on ecosystem services (ES) (Zheng, Fu, and Feng 2016). Sustainable development requires humans to reach a balance between the usage and protection of natural resources for social and economic development (Mccartney and Finlayson 2015). ES conserves diverse habitats for plants and animals and provides sustainable ecosystem goods, such as seafood, timber, and fuel (Daily 1997). The Millennium Ecosystem Assessment (MEA) (2005) defines four categories of ES: provisioning services such as food and water, regulation services that influence climate and water quality, cultural services that provide recreational benefits, and supporting services such as oxygen production and nutrient cycling. Urbanization threatens the sustainability of ES. For example, it endangers forest sustainability and management by increasing human infrastructure and activities (Nowak and Walton 2005). As the interactions between ES and urban growth are increasing with growing global population, it is imperative for society to seek a balance between the usage of natural resources and urban development.

Incorporating ES into management decisions for urban planning offers a promising approach to achieve conservation and sustainability of natural resources (Bremer et al. 2015). It can also show stakeholders and decision makers explicit trade-offs and synergies between different ES scenarios (Neuenschwander and Hayek 2014). The methods we can use to integrate ES with urban design include conventional 2D design, traditional 3D city modelling, and procedural 3D city modeling. The technology and decision methodology that support urban design has gradually transformed from 2D systems, such as a cadaster map, to a more flexible 3D modeling approach (Taylor et al. 2014). A 3D city model can help planners to intuitively predict and optimize urban design, especially for realizing reasonable urban spatial layout (Luo, He, and He 2017). However, building a traditional 3D model using AutoCAD or Sketchup software for a large district is time-consuming, expensive, and it requires high-performance computing resources (Luo, He, and He 2017).

In comparison to traditional 3D modeling, procedural 3D modeling is a flexible, grammar-based approach. Grammar-based modeling allows users to outline descriptive rules that iteratively define shapes or replace the original shapes with new ones (Xu and Coors 2012). The ability to build a 3D environment rapidly and to view it in various angles is effective for urban design and geodesign (Taylor et al. 2014). Geodesign is a method that combines design with simulated impacts and geospatial information to provide real-time feedback rather than post hoc assessment (Flaxman 2010). Esri's CityEngine is a rule-based 3D modeling software that is suitable for modeling both small and large cities. By using CityEngine and ArcGIS software together, we can solve the problems existing in traditional urban design such as difficulties in modeling complex processes, poor 3D visualization, inefficiencies for modifications, and poor public participation (Li, Han, and Hao 2013).

The City of Pocatello has initiated projects to enhance local ecosystem health, recreation access, and economic development. The Terry First project aims to enhance the connection between the historical Old Town area and Idaho State University since they both are the social and economic engines of Pocatello (City of Pocatello 2018). The Relight the Night project, which began in 2012, repaired and saved historic neon signs in the Old Town of Pocatello to remind the community of local events, places, and people (Old Town Pocatello Inc. 2018). In addition, the City of Pocatello started the Portneuf River Vision Study in December 2016, aiming to revive the relationship between communities along the Portneuf River by improving river corridor management and providing riparian restoration (Rowland et al. 2016; Sanger 2018) The

Idaho State University (ISU) research team, from the Managing Idaho's Landscape for Ecosystem Services (MILES) program, supported by the National Science Foundation (Award No. IIA-1301792), contributed to the efforts of the Portneuf River Vision Study. The research team studied the trade-offs and synergies of ES along the Portneuf river corridor and made recommendations based on balancing ecosystem health, public participation, and economic development.

Intensive exploitation of natural resources in urban areas has brought about serious environmental issues, such as heat island effects and air pollution. The influences from urban heat island effects are: (1) a reduction in evaporation due to increased paved surfaces and thus decreased vegetation coverage, (2) higher temperatures from low reflectivity of the built environment (3) and excessive heat trapped by urban pollution (OKE 2002; Tam, Gough, and Mohsin 2015). Esha and Ahmed (2006) studied impacts of land use and land cover changes on surface temperature in the northwestern region of Bangladesh and found that the temperatures were comparatively low in vegetated areas, but temperatures were higher in non-vegetated areas, where the temperature increased 6ºC from 2003 to 2011. Hence, utilizing reflective surfaces and planting urban vegetation are simple ways to cool land surface temperature (LST) and thereby mitigate heat island effects in cities (Akbari 2001).

Air pollution is a another serious environmental problem that undermines the sustainability of urban ecosystems and the quality of urban life (Jim and Chen 2008). Although cities occupy less than 3% of the earth's land surface, they create 78% of carbon emissions and pollutants (O'Meara et al. 1999; United Nations Human Settlements Programme 2006; Bereitschaft and Debbage 2013). Stone Jr. (2008) studied the impacts on air quality from different urban forms in large metropolitan cities and concluded that regions with a high ranking on an urban sprawl index had higher ozone concentrations. Consequently, urban forests can refine air quality and lower associated pollution health risks (Nowak et al. 2001). Jim and Chen (2008) noticed that urban vegetation can remove some pollutants in the air through dry deposition processes. This discovery allowed them to assess the monetary value of SO_2, NO_2, and other particulate matter removed by urban trees in Guangzhou, China, estimated at $745,000 annually.

The goals of this study were to build a 3D city model of present-day Old Town Pocatello, Idaho using a procedural modeling approach and modeling ES for the entire City of Pocatello in a possible future scenario with added trees and green spaces. In Chapter 2, I review the literature on 2D and 3D modeling methods for urban design and ecosystem services related to land surface temperature and air pollutants removal. In Chapter 3, I describe the methods and rule sets for building a 3D city model of Pocatello and how to visualize the results using ArcGIS Pro, CityEngine, and Unity Technologies software to develop mobile, online, VR, and 3D games for public participation. In Chapter 4, I model ES response to a potential future scenario for the City of Pocatello with increased tree cover and green spaces that regulate UHI and air quality. Chapter 5 incudes a summary of the study that will help decision makers in the City of Pocatello evaluate the potential of geodesign for urban redevelopment planning and analyze ecosystem service response based on future scenarios both visually and statistically.

Chapter 2 Literature Review

2.1 Ecosystem services

Ecosystem services (ES) support human survival and welfare (Costanza et al. 1997; World Resources Institute 2005; Manes et al. 2017). Daily (1997) first described the definition of ES as “the conditions and processes through which natural ecosystems, and the species make them up, sustain and fulfill human well-beings.” Our understanding of ecosystems has changed over time. The MEA (2005) defined ES as the benefits that people get from ecosystems which includes provisioning services such as food and water, regulation services that influence climate and water quality, cultural services that provide recreational benefits, and supporting services such as soil formation. Nelson et al. (2009) explained that ES is a collective term for all goods and services that are important for human beings.

The sustainability provision of urban ES becomes increasingly important for city dwellers (Qureshi, Breuste, and Lindley 2010). City dwellers’ quality-of-life partially depends on locally generated ecosystem services. However, due to the growth of urban population, certain ecosystem services have exceeded a city’s limits, such as air quality and noise levels (Bolund and Hunhammer 1999). The goal of sustainable development in the urban area is to improve human welfare and to protect natural resources (Cohen-shacham et al. 2017). Ecosystem services play an important role in building resilience in urban areas since it describes how to shape the relationship between humans and the environment and how to reduce biodiversity loss to meet the needs for present and future generations (Mcphearson et al. 2014; Schröter et al. 2017).

The degradation of natural lands in urban contexts puts more stress on green infrastructure to provide equivalent ecological functions as rural areas (Lovell and Taylor 2013). It is ecologically, socially, and economically desirable to invest in green infrastructure in cities, since urban green spaces provide supports in multiple ES: (1) regulating services such as air filtration and surface temperature regulation (2) cultural services such as recreation and urban aesthetics purposes and (3) supporting services such as habits for biodiversity (Green et al. 2015; Elmqvist et al. 2015; Yilmaz and Mumcu 2016). The cultural ecosystem services provided from urban green spaces can help to implement social equity and to reduce social determinants disease (Jennings, Larson, and Yun 2016).

Researchers are exploring various methods and tools to measure the valuation of ES and to understand trade-offs and synergies among different regulating, supporting, and provisioning ES. Grêt-Regamey et al. (2013) generated possible scenarios for a city in Abu Dhabi in an interactive and 3D embedded GIS platform that showed ES values and trade-offs such as cooling effects and water usage. Radford and James (2013) also created an ES assessment based on the Residential Environment Assessment Tool (REAT). It helped stakeholders in understanding synergies and trade-offs among ES along a rural–urban gradient by assigning them non-economic values from 0 to 10. Regarding the measurement for cultural services, Plieninger et al. (2013) mapped, assessed, and quantified cultural services, including aesthetic values, social relations and educational values from interviewing 93 residents.

Integrating ES into decision-making in natural area management is a promising approach (Bremer et al. 2015; Ament et al. 2016). Reyers et al. (2013) outlined a Social-Ecological System (SES) framework to help planners and decision makers measure ES and its values by integrating ecological and social factors to test designing hypotheses. Geodesign is also a promising method for managing urban natural resources since geodesign can display to stakeholders a design proposal and its simulated geographical impacts using real-time data (Flaxman 2010; Eikelboom and Janssen 2015). However, there are still many challenges to integrating ES in landscape planning, management, and design. For instance, it is hard to find appropriate methods to quantify and value ES and to display trade-offs and synergies between different types of ES, especially cultural services (de Groot et al. 2010; Grêt-Regamey et al. 2016).

2.2 Modeling for urban design

Urban design was first developed in North America in the 1950's (Rowley 1994). Rowley (1994) proposed that urban design is a response to urban change and development that can meet both social and emotional needs for city residents, thereby presenting a safe and accessible public area. Ian McHarg, an architect and designer, introduced a method for optimizing land-use system in urban design by overlaying natural spatial data on local terrain for decision making in his 1969 book *Design with Nature* (Fleming et al. 2019). The basis of traditional urban design was in 2D perspectives such as 2D paper maps. Yet traditional modelling approaches focused on either temporal or spatial variation, but not both (Ahmad and Simonovic 2004). Traditional 2D urban design also has other problems. Li, Han, and Hao (2013) stated that traditional urban design methods lack 3D visualization, interactive rulesets, and public participation. Interactive, 3D visualization offers the means to better engage with the public.

3D city modeling improves stakeholder's understanding and provides a more vivid visualization than 2D GIS by displaying a city's skyline, ridgeline, and building heights in a true perspective (Guo et al. 2017). The scale of urban design varies from nationwide to streetscapes and the theme differs from urban redevelopment to historical protection (Rowley 1994). Guo et al. (2017) used 3D GIS to simulate the impacts of various development densities on urban skyline, mountain ridgeline, and solar exposure that can assist planners, developers, and decision makers to make informed decisions. Since almost every city has historical areas, 3D city modelling is also useful for redeveloping old urban districts (Luo, He, and He 2017). Although

3D models are effective visualization tools, they have limits. For example, high-performance computer graphic cards and high-cost monitors with a fast screen refresh rate are needed in the design process (Parish and Müller 2001; Wang et al. 2018).

Procedural 3D modelling offers potential to support urban planning and geodesign. Geodesign is a new planning method that combines geography and design in a set of supporting tools to assist decision making processes (Trubka et al. 2016). Geodesign can also enhance urban design methods by integrating planning, designing, simulating, and evaluating changes (Ervin 2011). Procedural modelling is entering the mainstream in urban planning because it can make up for the shortcomings of traditional urban design in terms of both efficiency and public interaction. Procedural modelling uses grammar rules to interactively associate polygons with their attributes, such as built year, height, and property values, and facilitates both temporal and spatial variation (Watson et al. 2008). For example, CityEngine is a 3D modelling software that utilizes Computer Generated Architecture (CGA) rules to create 3D shapes. Schaller et al. (2015) created a web-based application for Cologne, Germany that simulates present and future 3D city scenarios, thus helping local residents to understand the terms used in the urban planning process and to visualize possible scenarios in a real-world perspective. Mustafa et al. (2018) also used CityEngine and procedural modeling method to design a 3D GIS-based hydraulic model for urban layout planning. This hydraulic model can passively decrease water depth in a flooding scenario.

Immersive geodesign utilizing virtual reality technology can improve user experience by displaying a highly-realistic environment (Davis 2016). The introduction of CityEngine software can help innovate 3D GIS and geodesign in urban planning by providing an immersive 3D visualization (Koehl and Roussel 2015). Davis (2016) created an immersive 3D city model for the city of Morgantown, WV to tackle the visualization issues in geodesign processing using Trimble Sketchup, CityEngine, and virtual reality technology.

2.3 Urban heat island effect

Urban heat island (UHI) effect is a phenomenon generated by anthropogenic activities, it only occurring in urban areas when the urban center is warmer than its suburbs (Tam, Gough, and Mohsin 2015). UHI is normally estimated by the relationship between Normalized Difference Vegetation Index (NDVI), which indicates vegetation abundance, and land surface temperature (LST) (Weng, Lu, and Schubring 2004). Mapping and modeling LST effect in cities can help decision makers to detect which region has severe UHI effects, so the planners can choose a better land use management design (Handel et al. 2015). For example, Avdan and Jovanovska (2016) presented an algorithm for the automatic mapping of LST using band 10 and 11 (Table 1) Landsat 8 data. Whereas, Rota, Gravante, and Zazzi (2019) created a decision-making tool that modeled a UHI risk map for the city of Parma, Italy to help planners and policy makers identify thermal hotspots within their study area. ES for climate regulation is associated with regulating UHI effects since the surface temperature in central cities is higher than its surroundings (Marando et al. 2019). LST in urban and rural areas are significantly different because urban areas have more impermeable surfaces, such as roads and parking lots. However, water bodies and green belts can mitigate LST by evaporative cooling, reducing rainwater drainage for cities, and creating more recreation sites for city residents (Chen et al. 2014). A common approach to calculate LST is using thermal bands from Landsat thermal infrared images. Sun and Chen (2017) studied the relationship between green infrastructures (GI) and LST and concluded that there was a 1.64 – 2.21 °C increase in green infrastructure loss areas in Beijing, China. In the meantime, Yang, He, Yu, et al. (2017) examined the relationships between urban park characteristics and park cool islands (PCIs) using Landsat 8 TIR images from May to October 2017. They found that larger parks tended to have stronger PCI intensities and extent of influence to other areas, especially in the hottest months.

Table 1. Landsat 8 Operational Land Imager (OLI) and Thermal Infrared Sensor (TIRS)

Band	Wavelength (micrometer)	Spatial Resolution (meter)
1 Coastal Aerosol	0.435 - 0.451	30
2 Blue	0.452 - 0.512	30
3 Green	0.533 - 0.590	30
4 Red	0.636 - 0.673	30
5 Near Infrared (NIR)	0.851 - 0.879	30
6 Short Wave Infrared (SWIR) 1	1.566 - 1.651	30
7 Short Wave Infrared (SWIR) 2	2.107 - 2.294	30
8 Panchromatic	0.503 - 0.676	15
9 Cirrus	1.363 - 1.384	30
10 Thermal Infrared (TIR) 1	10.60 – 11.19	100*30
11 Thermal Infrared (TIR) 2	11.50 - 12.51	100*30

Source: https://landsat.usgs.gov/what-are-best-spectral-bands-use-my-study

2.4 Air quality regulation

Air pollution is a serious problem in most cities around the world (Meloni 2003). ES can enhance air quality by planting trees since trees to abosorb air pollutants such as particulate matter (Smith et al. 2013). Conventional air pollutant management only focuses on controlling the source of air pollutants; however, innovative approaches focus on reducing exsiting air pollutants (Manes et al. 2017). Vegetation, such as tree canopy, grasslands, and shrublands, can improve air quality by sequestering air pollutants onto their surfaces (Gopalakrishnan et al., 2018). Nowak, Crane and Stevens (2006) proposed a feasible option for reducing air pollutant concentrations by planting more trees, since urban trees can reduce many kinds of air pollutant such as 0_3, PM_{10}, NO_2, SO_2, and CO. Gopalakrishnan et al. (2018) quantified the air pollution removal capacity of grasslands and shrublands at the county-level in the United States and estimated the monetary value assosicated with human health benefits at $268 million for 2010.

It is important to consider ES concepts to improve sustainable development in urban areas (Kremer, Hamstead, and McPhearson 2015). Jayasooriya et al. (2017) created a tool that displayed how much air pollution could be reduced and how much energy could be saved by adding more GI. They created different GI scenarios for Melbourne, Australia using i-Tree Eco software to help decision makers choose the most sustainable GI scenario for the study area. Similarly, Baró et al. (2014) created a tool that quantified biophysical benefits and monetary values provided by urban forests to assist decision makers. Baró et al. found that GI is an effective method to reduce urban pollution. However, even though trees can mitigate air pollution issue in cities, trees produce allergens in their growing seasons, which can cause allergic reactions and decrease air quality. Consequently, it is important for city planners to consider tree characteristics as part of the urban planning process (Grote et al. 2016).

Chapter 3 Procedural 3D modelling for the Old Town in Pocatello, ID

3.1 Introduction

Cities around the world have been growing rapidly. The population in urban regions constitutes over half of the world population, and it will reach 68% by 2050 (United Nationas 2018). As of 2018, 80% of the American population resides in urban regions, growing from 64% in 1950 (Center for Sustainable Systems University of Michigan 2018). Urban expansion encroaches upon natural resources, which results in a decrease in ecosystem service (ES) values (Su et al. 2012). The Economics of Ecosystems and Biodiversity (TEEB) (2010) defines ES as the direct and indirect benefits from ecosystems to human beings. Urbanization has changed land use and cover in urban areas and incurred negative influences on ES. Intensive urban development reduces tree density and increases the amount of impermeable surfaces in cities leading to higher temperatures, lower air quality, and more flooding (Mcpherson, Nowak, and Rowntree 1994). Yang, He, Yu, et al. (2017) found that the thermal environment increased dramatically as urban areas in Changchun increased fourfold over 30 years. Therefore, it is important to understand how human interactions, design, planning, and management methods can contribute to supporting ES in urban regions.

As cities grow, it is necessary for planning authorities to improve their support systems so that they can make appropriate decisions for sustainable future development (Sameeh, Sayad, and Ayad 2019). Ian McHarg initially designed an urban designing approach that integrates natural spatial data with city planning in his 1969 *Design with Nature* book (Fleming et al. 2019). Urban and regional planners first introduced planning support systems in the late 1980’s based on McHarg’s design with nature method. As geographical information systems (GIS) emerged in the 1990’s, more tools were created for supporting urban planning processes (Batty

2007). We can use maps that involve geodesign tools to support stakeholders in collaborative planning and to increase the effectiveness of spatial designing (Eikelboom and Janssen 2015). Geodesign is an innovative approach that can help planners to integrate proposed ideas with simulated impacts for pre-assessment (Flaxman 2010). The current major limitation in urban analysis is that city planners do not consider the vertical dimension (Koziatek and Dragićević 2017). The conventional 2D plan of a city restricts planners' conceptualization of the vertical volume of a region (Ahmed and Sekar 2015). GIS-based 3D city models are attracting more attention in the urban design field as new planning concepts are introduced to the public, such as the smart city (Luo, He, and He 2017). A smart city is a city that focuses on new information and communication technologies (ICT) to achieve a sustainable society and to provide a better quality of life for citizens (Albino, Berardi, and Dangelico 2015). However, there are still some challenges regarding 3D city modeling. For instance, it is time consuming for an operator to build new 3D models, available software is challenging for the novice user to learn, and it requires powerful computing resources and expensive monitors with high performance graphics cards (Parish and Müller 2001; Paar 2006; Wang et al. 2018). To overcome some of these limitations, procedural modeling offers a cost-effective solution as it can generate numerous 3D models interactively based on grammar-based rules that are faster to implement and require fewer computing resources to render. Thus, planners can leverage these advantages to improve urban development and management (Breuste and Qureshi 2011).

Procedural modelling has the potential to solve complex and time-consuming problems in 3D urban design. Procedural techniques have been successfully and widely used in computer graphics to create 3D textures of natural objects such as waterfalls and trees (Kelly and McCabe 2006). Fast speed, random and structured models, and controllable contents are three essential advantages of procedural content generation (Parberry 2014). Tiwari and Jain (2013) used procedural modeling to include an economic component, an environment component, and a social component to create an innovative and smart 3D city. The economic component includes the cost of development and monetary values from the energy saved by green infrastructures; the environmental component includes air pollutant concentrations and shade areas provided by trees; the social component includes recreation opportunities and aesthetic values. Adrienne Grêt-Regamey et al. (2013) used CityEngine (Esri) to generate scenarios for different urban designs using interactive slider bars that offered stakeholders the ability to explore ES tradeoffs (micro-climate regulation and habitat services) in Abu Dhabi, Masdar City, United Arab Emirates.

Procedural modeling approaches emphasize on generating 3D objects and textures based on a set of rules instead of user input (Singh, Jain, and Mandla 2014). Procedural modelling is available in CityEngine, a robust and efficient 3D modelling software that controls models by defining rules with Computer Generated Architecture (CGA) (Grêt-Regamey et al. 2013). CGA is a shape grammar that is capable of efficiently building large cities with descriptive rules that define infrastructure and environments (e.g. Rules can generate windows and doors for buildings and cars and people on the street); it was originally developed by Müller et al. (2006). We can apply CGA rules to GIS data to model trees, streetscapes, landscapes, and buildings (Albracht 2016). For example, a CGA rule for trees can populate trees across an entire model using attributes and parameters, such as tree species, tree height, and crown area, from a tree point feature class. Fanini et al. (2012) created an online and real-time application for a Roman archaeological site. They reconstructed landscapes from laser scanning and photogrammetry datasets, and then generated thousands of local buildings using a procedural modeling method (e.g. They assgined a shape grammer rule in CityEngine that defines building size, height, aspect, and texture to building footprint data). Schaller et al. (2015) created a web-based application for Cologne, Germany to display sustainable growth scenarios for a new development using LiDAR data and a procedural modeling approach (e.g. They create rules to render open spaces, green spaces, and water bodies according to a landuse type in the attribute table). 3D geo-visualization techniques in procedural modeling can not only render the current state of a city, but also create future scenarios for sustainable and innovative growth that can be embedded in a Virtual Reality (VR) environment and web applications (Batty 2007; Schaller et al. 2015).

Ivan Sutherland originally invented VR and presented a head mount display (HMD) in the late 1960s. HMD then evolved into consumer-aimed VR headsets in 2012, such as the Oculus VR and the HTC Vive (Sutherland 1975; Hayek 2016). For example, the HTC Vive includes a headset, two controllers, and two motion tracking base stations. VR enables users to immerse themselves into dynamic virtual landscapes, which is an advantage for urban designers to assess landscape changes or proposed urban development (Slater and Wilbur 1997; Hayek 2016). A virtual city that uses VR technology and spatial GIS data can display real-time design concepts to the public in an interactive virtual environment. Sameeh, Sayad, and Ayad (2019) proposed a VR-GIS model to link the northern and southern Gaza Strip, and created multiple scenarios to assist the urban planning and consulting processes. However, the effectiveness of how VR can present an immersive environment to stakeholders in urban planning has not been well researched (Hayek 2016) and is still at an experimental stage (Jamei et al. 2017).

Pocatello, Idaho is a medium-sized city located in southeast Idaho with an estimated population of 55,193 that is expected to reach 60,000 in 2030 (City of Pocatello 2015). Pocatello is facing a range of challenges regarding sustainable future growth. For example, improving water quality and riparian ecosystem health for the Portneuf River, which runs through the city, are challenges that Pocatello is facing (Rowland et al. 2016). Managing Idaho's Lanscapes for Ecosystem Services (MILES) was a National Science Foundation (NSF) funded program that studied social-ecological systems for urban growth and ecological change in medium-sized and small cities in Idaho (Award No. IIA-1301792). For example, Hale, Cook, and Beltrán (2019) quantified cultural ecosystem services (recreation, aesthetics, and cultural heritage) of rivers in Idaho using Flickr geo-tagged images and texts. Narducci et al. (2019) measured the public perception of ES trade-offs in Boise, Idaho from 400 surveys where city growth is resulting in a reduction in farmland areas. Ogle et al. (2017) quantified a sustainable urban growth model for the City of Pocatello utilizing a 2D approach upon which this study builds.

This chapter focuses on Old Town Pocatello, Idaho. Old Town Pocatello consists of historical buildings and businesses in the downtown core of the City (City of Pocatello 2015). However, Old Town Pocatello is facing some challenges. Limited access to the Old Town area hinders its development, and a concrete channel segment of the Portneuf River acts as an unaesthetic barrier for public access to the river offering no recreational opportunities (Rowland et al. 2016). This study describes the process of building a rule-based 3D procedural model of Old Town Pocatello using ArcGIS and CityEngine and further visualized with VR tools developed using Unity software. Vector data outlining impervious areas, building footprints, trees, streetlights, fire hydrants, parking lots, green blocks, green grass area, etc. were pre-processed in ArcGIS software before importing into CityEngine. The 3D procedural model for Old Town in Pocatello utilized CGA rules to efficiently generate numerous 3D features in a short period of time—approximately from one to five minutes depending on the size of the area. For

VR simulation, the 3D objects were imported into Unity software to allow users to virtually walk inside the model wearing an HTC Vive headset. Other products generated included a mobile phone game that allows users to control a car with a joystick in the virtual environment and an on-line 3D walking tour of Old Town. The objectives for this chapter were to (1) build a 3D procedural model for Pocatello Old Town, (2) integrate key attributes in the model for planning and geodesign, and (3) visualization in 3D, VR, and WebGL.

3.2 Methods

3.2.1 Study area and data sources

This study developed a procedural model of Old Town Pocatello, Idaho along the concrete channel reach of the Portneuf River from Terry Street to Sacajawea Park (Figure 1). The Portneuf River supplies habitat for fish and wildlife, recreational sites for the public and is an irrigation source for farming. However, excessive alternations to the river have affected local ecosystem health and limited the public access due to concerns over flooding (Rowland et al. 2016). To cope with the serious flooding disaster of 1968, the US Army Corps of Engineers (USACE) constructed a concrete wall along the Portneuf in Old Town Pocatello with levees that can contain a flood of up to 170 cms (cubic meter per second) (Rowland et al. 2016). The concrete channel reach is approximately 2,414 m in length with different seasonal flowing rates from 0.85 cms in winter to 11.33 cms during spring (City of Pocatello 2015). The City of Pocatello, MILES scientists, and interested stakeholders are working together to improve the river ecosystem health, community engagement, and economic development for future sustainable growth.. Figure 2 illustrates the workflow used to create a 3D procedural model for Old Town Pocatello in its current state. The geospatial data for building the model included both vector and raster layers.

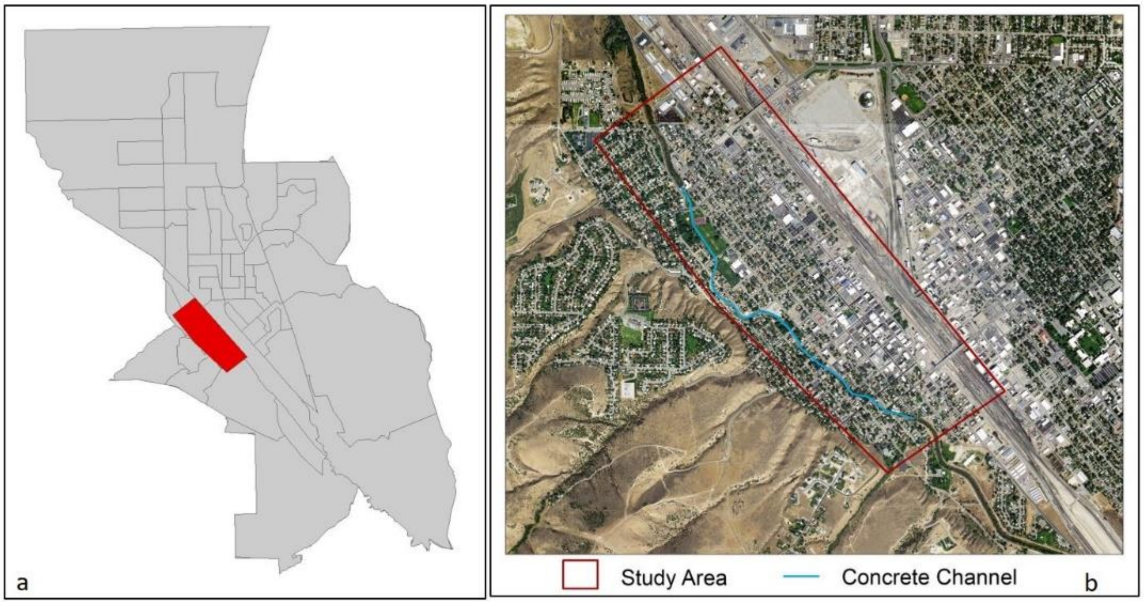

Figure 1. a. Pocatello Old Town. The red section highlights the study area within the City of Pocatello limits. The section inside the red boundary in b is the study area, and the blue line is the concrete channel section of the Portneuf River.

Table 2 and Table 3 show the sources and attributes of the data used. Vector data functioned as base layers for 3D components in the urban landscape. The polygon layers include building footprints, green space, green blocks, impervious areas, parking lots, railyards, and sidewalks. The building footprint data was combined with parcel attributes such as assessed value, property type, year built, etc. Point data included streetlights, street signs, and trees. Polyline data included streets, the concrete channel, and the Portneuf River that were sourced from Bannock County's GIS Department. Raster images consisted of 2013 NAIP orthoimagery with 1 m resolution and Digital Elevation Model (DEM) data with 1 m resolution collected in 2016 with airborne LiDAR (Oregon Dept. of Geology and Mineral Industries), Natural textures, such as brick wall texture, window frame texture, etc., for 3D objects from obtained from online creative commons image resources. The source for 3D objects, such as streetlights, signs, trees, etc., was 3D Warehouse website (https://3dwarehouse.sketchup.com/). Besides using online texture resources, I also used the pre-existing texture libraries available in CityEngine. For landmark buildings, such as Hotel Yellowstone, the Union Pacific railway station, and Bannock County Veterans Memorial buildings, I went to the sites and took pictures around each building. The software used in this study were ArcGIS Pro, CityEngine, and Unity. ArcGIS Pro and CityEngine are Esri software used for preparing data and building a 3D model. Unity is a gaming development platform for creating mobile and VR games.

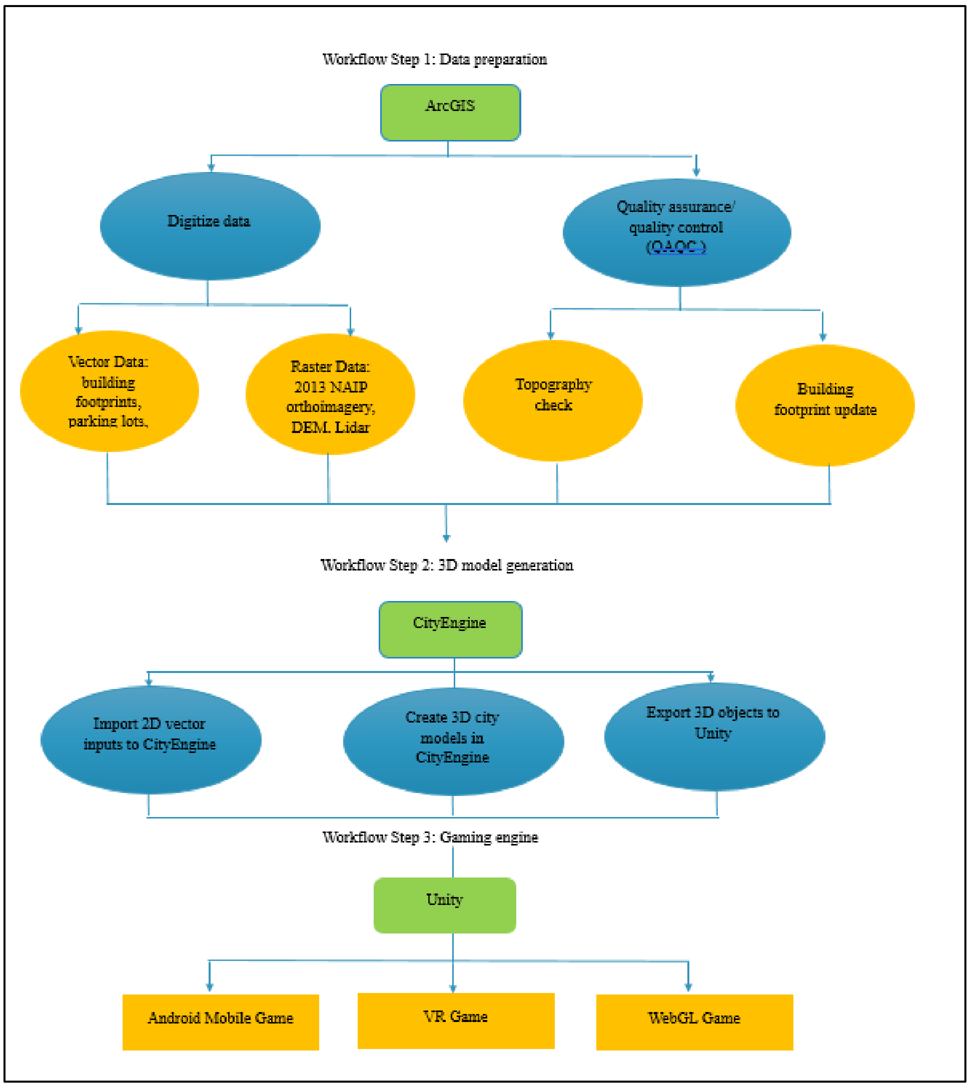

Figure 2. The workflow for creating the 3D model.

Table 2. Vector data sources

Data	Attributes	Sources
Building footprints	Parcel No., Parcel Owner, Property type, Year built, etc.	City of Pocatello
Trees	Address, Species, Condition, DBH, etc.	City of Pocatello
Fire hydrants	Hydrant number, Pipe number, Hydrant type, etc.	City of Pocatello
Street signs	File name code, Sign ID, MUTCD number, etc.	City of Pocatello
Streetlights	Subtype, Ownership, etc.	Idaho Power
Portneuf River	Length, Name, etc.	Bannock County
Streets	Description, Location, Condition, Road width, etc.	Bannock County

Table 3. Raster data sources

Data	Resolution (m)	Year	Sources
Digital Elevation Model (DEM)	1 m	2016	DOGAMI
Digital Surface Model (DSM)	1 m	2016	DOGAMI
NAIP orthoimagery	0.5 m	2013	USDA

* DOGAMI (Oregon Department of Geology and Mineral Industries)
*USDA (United States Department of Agriculture)

Workflow Step 1: Data preparation

The 3D city model in CityEngine used vector and raster input data. I digitized green spaces, green blocks, parking lots, railyard, building sidewalks, and impervious areas in the Pocatello Old Town based on NAIP imagery. Green spaces are the areas that are covered with green grass, including parks and school playgrounds. Green blocks include the surfaces that have partial or less grass coverage — specifically, resident backyards. Parking lots in Old Town Pocatello have five categories: commercial, public, residential, school, and business. Commercial parking lots are for customer parking. Public parking lots are the parking spots for business purposes for their employees that customers do not use. Public parking owned by the

City of Pocatello opens to residents at no charge. School parking lots are local school's property. Building sidewalks were the buffer surfaces in front of buildings. Impervious areas are the concrete or compacted surfaces that are difficult for water to penetrate.

Quality assurance and quality control (QA/QC) checks were done to confirm the building footprint data was correct. Corrections were made by deleting or adding building polygons in comparison to NAIP imagery. The next step was to add roof type for each building using Street View in Google Maps to classify them into flat, gable, hip, pyramid, or shed types according to their slopes (Figure 3). Since all polygon and point datasets required height attributes in the 3D model, I extracted height information for each feature from a Surface Change Model (SCM). The equation for estimating SCM is shown equation (1). DSM is digital surface model from 1st return LiDAR data, and the DEM is digital elevation model derived from last return LiDAR data, both datasets were available from the 1 m resolution DOGAMI LiDAR.

$$SCM=DSM-DEM \qquad (1)$$

To fix false values, I double checked the height parameter for each individual building to correct for errors generated from overhanging trees. Polyline street segments were split at intersections and overlaid on the center of roads as viewed in the NAIP imagery. Also, I added left and right sidewalk widths and road width to the streets layer. Lastly, it was necessary to set the topography rules to verify that the data did not have any overlaps.

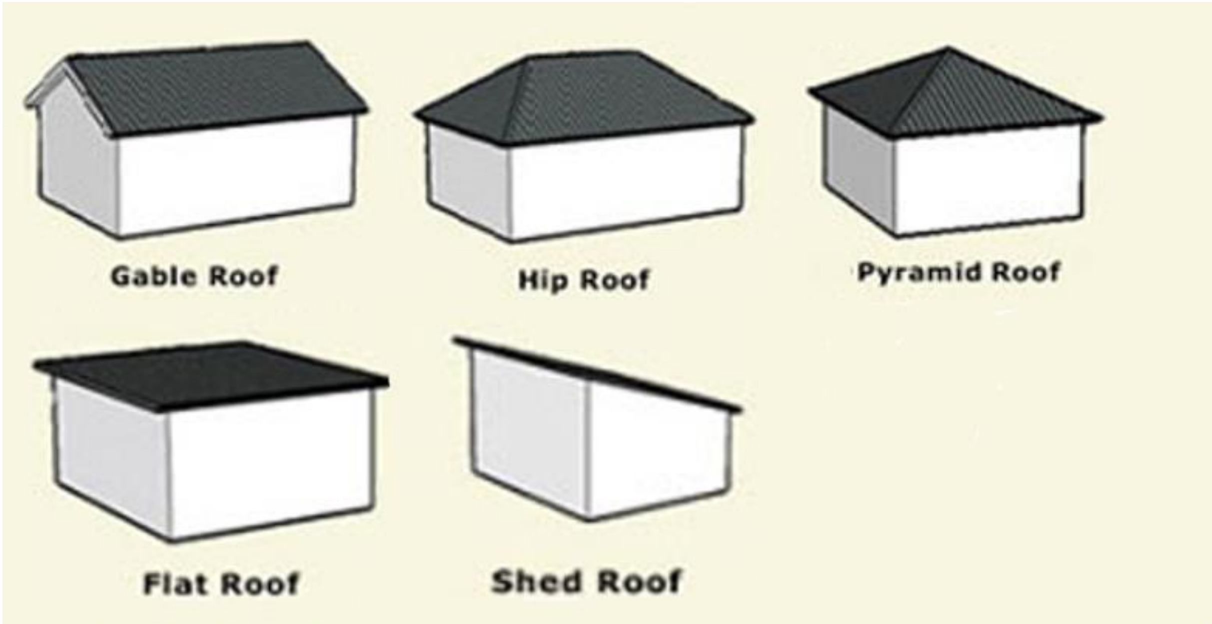

Figure 3. Illustrations of different roof types from American Standard Roofing, LLC.

(source adapted from: https://www.americanstandardroofing.com/homeowners-guide-to-sloping-roof-types/)

Workflow Step 2: 3D model generation

Esri's software CityEngine is a 3D modelling application with a built-in programming language called CGA rules (Kim and Wilson 2014). CityEngine automatically generates nine folders to organize datasets when creating a new project, including assets, bin, data, images, maps, models, rules, scenes, and scripts folders. The data management in CityEngine for the Old Town Pocatello model was as follows: the assets folder stored 2D textures and 3D objects, the data folder contained GIS geodatabase, and the image folder was for raster data, the models folder was the default folder for saving offline 3D web scenes, the rules folder has CGA rules for different elements in the scene, and the scripts folder contains Python scripts.

Procedural modelling interactively generates massive objects in 3D urban models (Grêt-Regamey et al. 2013). First, I imported the DEM and orthoimage to the scene as height and texture files. CityEngine overlapped and merged those two layers into one map and used it as terrain base layer for georeferencing other inputs. The next step was to add feature classes into the scene and align the shapes to terrain so that they had real-world elevations. To generate 3D models, I wrote and applied CGA rules for each layer. CGA are a set of rules that gives the shapes natural textures to make them look realistic. Rules extruded 3D shapes for stop signs, fire hydrant, and streetlights to their standard heights and extruded buildings and trees to their actual heights according to their attributes. After that, I modified Esri's Complete Streets rule, written by David Wasserman, to generate the streetscapes in Pocatello including pedestrians, cars, buses, and road marks. In addition to 3D shape generation, I used CGA rules to create statistical forms for views that held useful attributes relative to urban planning and ES. For instance, year built and housing values are important properties in the buildings layer for urban planning. Total impervious area can help city planners to evaluate the impervious percentage in Pocatello. Over 40 percent natural vegetation landscapes have been replaced by impervious surface in 2008 as cities expand and the direct impact is increasing LST, which could cause a urban heat island effect (Gluch, Quattrochi, and Luvall 2006; Sterling and Duchame 2008; H. Xu 2010). CityEngine does not have a complete toolkit for geospatial analysis. However, Python scripts can make up for this deficiency. Thus, I wrote Python scripts to run advanced operations such as export selected objects (Appendix A), query by attributes (Appendix B), regenerate the 3D model (Appendix C), and export a statistics report for selected features (Appendix D).

CityEngine can export graphs, shapes, and models and while also offering various 3D exporting formats (Esri CityEngine 2019). CityEngine allows users to export a 3D view of the CityEngine model via the Esri Scene Layer Package, CityEngine Web Scene, and 360 VR Experience to ArcGIS Online. I also created an exporting script, to allow decision makers to interactively export a statistical report for selected features in text format. Further, I exported all the textures and models in FBX format and organized them in separate folders for each layer so that it was ready to be imported in Unity for more immersive visualizations.

Workflow Step 3: Gaming engine

Unity is a 3D gaming software development platform with a powerful rendering engine for creating interactive 2D, 3D, and VR content (Unity Technologies 2016). Unity starts a new project in a scene with a main camera and directional light. The organizing method for this project was to give each input element its own folder. For example, the material folder held all the texture JPEG files and 3D objects used in the Old Town Pocatello scene. It was necessary to import textures prior to objects. Otherwise, objects lost their textures in the scene. Then I generated mesh colliders for environment collision so the physical system, such as first-person or third person players, can stand on a solid surface. This process can take some time depending on the meshes' size and devices.

For public engagement, I developed 3D and VR games in Unity based on the Old Town Pocatello scene. It was necessary to download and install Standard Assets package from Assets Store in Unity for building 3D games. This package includes first-person, third person, car, aircraft, rollerball controllers, and cross platform input with various mobile control rigs. I added a first-person FPS controller to the project. Then I removed the default main camera since the FPS controller has a camera attached to it. The FPS controller is an invisible capsule collider controlled by a C# script that has parameters including walking speed, running speed, etc. The FPS controller will walk the avatar towards the direction where the camera is facing. Mouse and arrow keys can control the direction and movement. Unity has various platforms for building and exporting the contents, including PC, Max and Linux standalone, Android, WebGL, iOS, tvOS, Xbox, PS4, Universal Windows platform, and Facebook. Finally, I published this walking game online using a WebGL build option in Unity that allows users to run the game in a web browser (Figure 11).

I also developed a mobile game for an android phone that lets users control a car inside the model using a joystick. The first step was to import vehicles and cross platform input packages from the Assets Store to Unity. Then I added a car and a mobile single stick control to the scene view. The car is linked with a C# code that stores parameters for controlling the car such as top speed. The mobile single stick control has a joystick and it is enabled when the platform is switched to Android. Besides direction operations, I added a restart UI button to reload the scene. After that, I moved the main camera to the back side of the car and attached the camera to the car, so the camera will move with the car. To build an Android game, it is required to install SDK and JDK into Unity as external tools. Lastly, I exported the whole project as an apk file to be installed as an application in android phones (Figure 12).

For an interactive VR perspective, I developed a touchpad walking simulation. It is required to install the SteamVR plugin in Unity. The SteamVR plugin, which is maintained by Valve corporation, helps developers to connect with one PC VR headset, load 3D models, and handle inputs for VR controllers (Unity 2016). The HTC Vive headset and controllers were used in this study. I imported the VR toolkit (VRTK) to Unity. VRTK has a touchpad walking script that was added to a camera rig, so one can navigate the scene in first person. After that, I set up the camera rig from SteamVR and attached a touchpad movement script to both left and right controllers. The players can control their movements by sliding a finger over the touchpad. The players can walk towards the direction that they face.

3.3 Results

3.3.1 CityEngine

Figure 4 displays the percentage of the Old Town Pocatello land cover types. The overall area that the buildings covered was 414,341.8 m^2 of the total area of 2,831,722.1 m^2 which is 15% of the entire Old Town area. 22 % of the land cover is streets and sidewalks. Parks accounts for 3%. 33% of the land surface is covered by resident green blocks. Residential green blocks are unoccupied or undeveloped parcels with a mix of plant and dirt cover. Water body areas in the Old Town area is 37,398.2 m^2 (1%). Other impervious surface makes up 19% of the total. Thus, the percentage of impermeable surfaces in the Old Town area is approximately 63%.

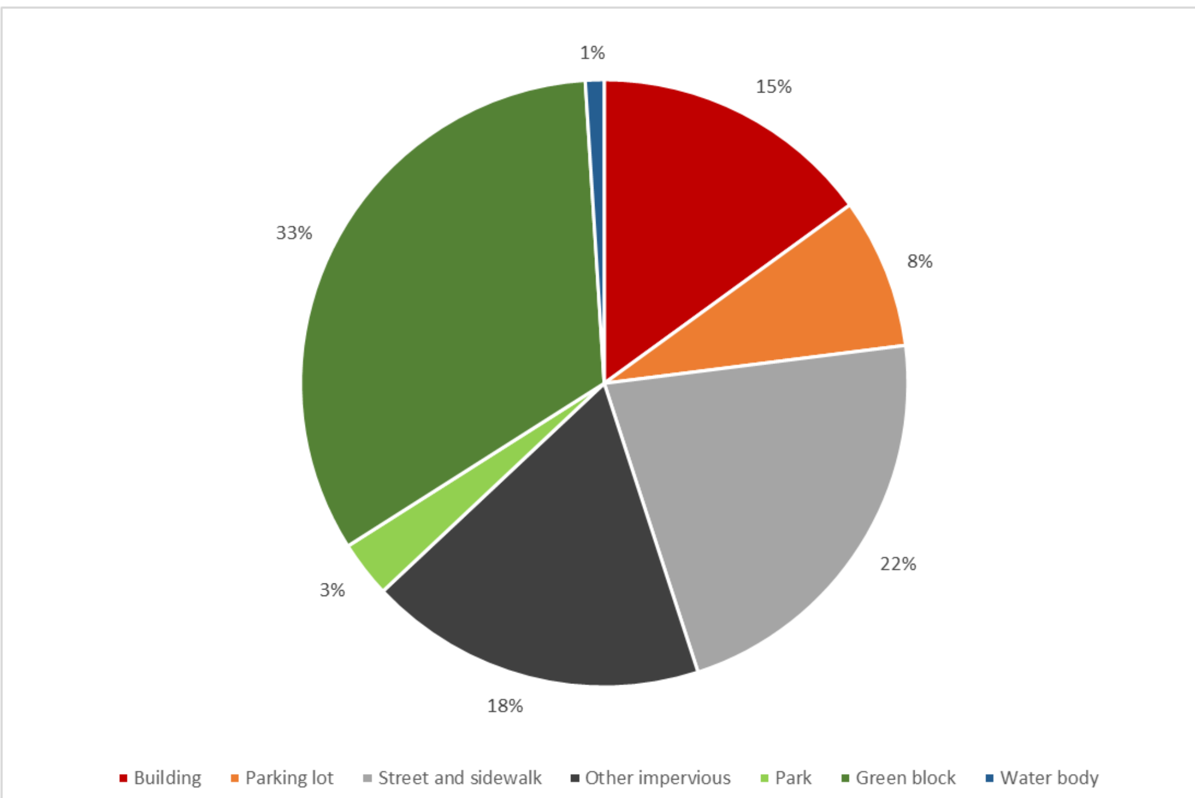

Figure 4. Land cover types in Old Town Pocatello.

There are 2762 buildings in Pocatello Old Town and the range of the buildings' heights is from 3.1 m to 21 m. Over 90% of the buildings in the Old Town Pocatello were built between 1900 to 1960, as shown in Figure 5. Only 7% of the buildings were built after 1960 and the rest were probably built before 1900. There were nineteen buildings that did not have built year records. Currently, Old Town Pocatello has 162 parking lots that cover 221,622 m^2. Most of the parking lots in this area are for commercial use, accounting for 52% (Figure 6). One-fifth of the parking lots are for business purposes; residential parking lots accounted for 18 % of the total. Schools and public parking lots have the same coverage that is 5%. There are seven parks included in this study area: Pioneer Park, Simplot Square, Old Town Park, and Raymond Park. They cover 73,888 m^2 in total.

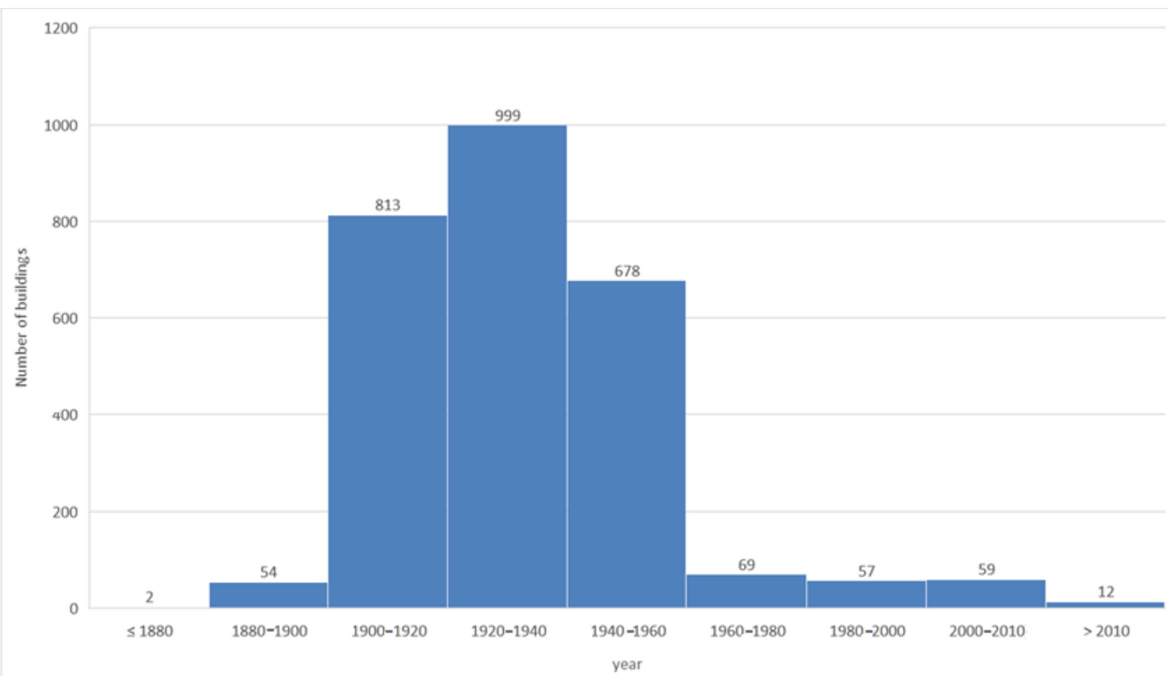

Figure 5. Building year built in Pocatello Old Town.

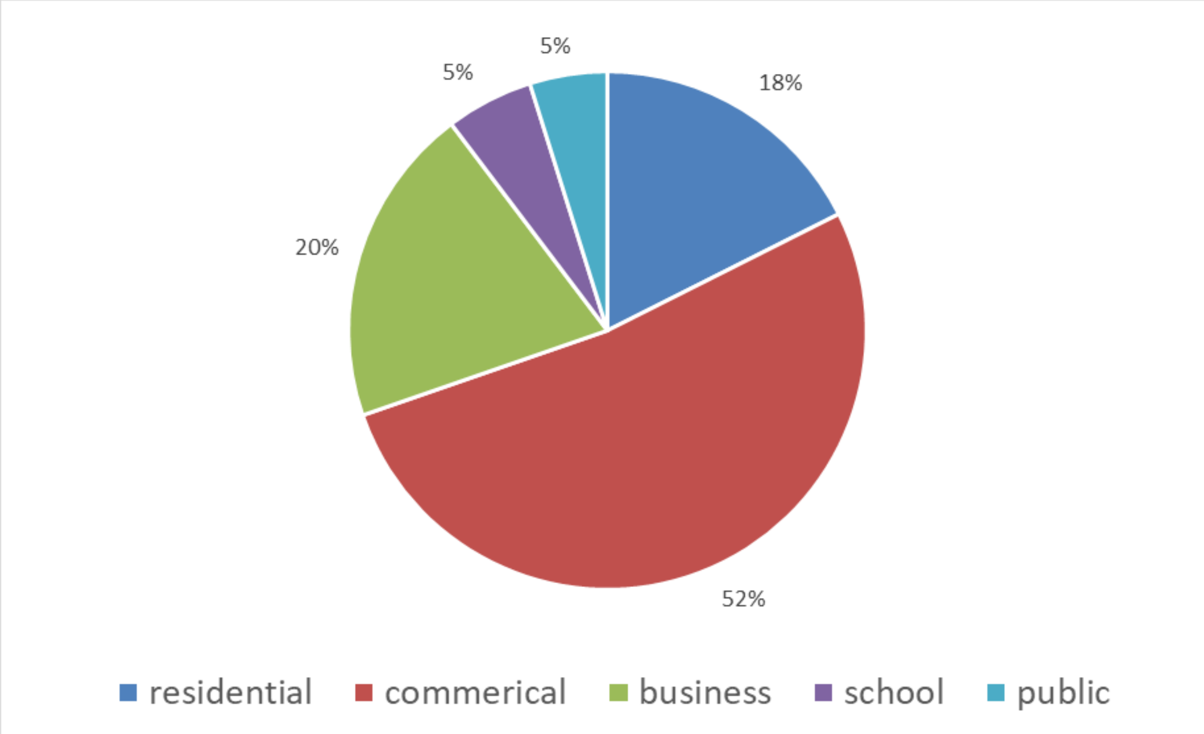

Figure 6. Parking lot types in Pocatello Old Town.

Figure 7 displays the overview of the present-day 3D scenario in Pocatello Old Town. It includes buildings, the concrete channel reach, Portneuf River, parking lots, streets, trees, hydrants, pedestrians, cars, etc. The published web scene on ArcGIS online was 160MB in size. The concrete channel flows through Old Town Pocatello and separates the study area into two sections. We can zoom in to the scene and check the details in this 3D model. The landmark buildings have textures captured with a camera in Pocatello, such as the Hotel Yellowstone and rail station, as displayed in Figure 8. The concrete channel reach and Bannock County Veterans Memorial Building are shown in Figure 9. Figure 10 shows two scenarios: present-day scenario and a proposed green scenario at a block scale in a 3D model. The parking lots near the Hotel Yellowstone are converted into turf block parking lots in the green scenario. The CityEngine model has been archived to the MILES model repository (https://www.idahoecosystems.org/products) and is available for public viewing via ArcGIS Online (http://bit.ly/2C58sa9).

Figure 7. CityEngine 3D model of Old Town Pocatello in ArcGIS Online.

Figure 8. CityEngine model showing Hotel Yellowstone and the Union Pacific Railway Station in CityEngine.

Figure 9. CityEngine model displaying the concrete channel reach of the Portneuf River and the Bannock County Veteran Memorial building.

Figure 10. Visualization at a block scale for present and proposed scenarios in CityEngine.

3.3.2 Unity WebGL, Android mobile game, and HTC Vive visualizations

The public has free access to the Unity developed WebGL walking game on Idaho State University's Geo-visualization website: http://geoviz.rdc.isu.edu/Walking/WalkingInDowntownPocatello.html. The instructions for this game display on the left side (Figure 11). The players can move the camera using their mouse. WASD keys or arrow keys control the movement: the A key is for moving left, the D key is for moving right, the W key is for moving forward, and the S key is for moving backward. The walking game works best in Firefox and Chrome. Internet Explorer does not support Unity WebGL content.

Figure 12 displays the interface of the Android mobile game I developed. The user view is from the back side of the car. There are two operation buttons on the left side. The joystick is on the left bottom corner. The white arrows indicate different directions where user may drive. The starting location is next to the Hotel Yellowstone. The restart button is on the left top corner. Once the user clicks on the restart button, it will load the game again and start at the beginning site. This mobile game is accessible and free to the public and is available for Android phones and desktop computers. The community can download the apk file or the executable file from MILES website (https://www.idahoecosystems.org/products) and install this app on their phone or desktop.

Figure 11. Unity WebGL walking game in a Firefox browser window

Figure 12. The mobile game in Android phone that allows user to drive a car

The VR game developed in Unity allows a user to virtually walk inside the Old Town Pocatello. The user needs wear an HTC Vive headset, hold two controllers, and stand inside the tracking area. The users can control their virtual avatars' movements in the scene via a touchpad to go left, right, forward, or backward. The height of the virtual avatar is 1.8 m. All the objects in the virtual scene, such as buildings, trees, and cars, are the same size as the real world. The HTC Vive visualization work has been archived in MILES data and model repository (https://www.idahoecosystems.org/products).

3.4 Discussion

It is difficult to comprehensively implement sustainable urban development without appropriately interpreting and visualizing the associated environmental and urban infrastructure data. Procedural 3D modeling has the potential aid urban planners and stakeholders to query and visualize potential development scenarios to make better decisions (Schaller et al. 2015). This study provides a complete workflow for creating a 3D city model and web applications for a case study in Old Town Pocatello. CityEngine supplies an interactive 3D modeling platform for urban design. CityEngine utilizes a procedural modelling method to create 3D objects using CGA rules. Procedural modelling is an effective method to create 3D urban models in CityEngine across a large area ranging from a neighborhood to an entire city (Li, Han, and Hao 2013). For example, CityEngine generated the Pocatello Old Town model within eight minutes on a laptop computer with an i7 processor of 4 cores, and 16 GB RAM. Further, it is suitable to transform GIS data from ArcGIS software into CityEngine since they are compatible Esri products and many cities and counties use ArcGIS software in their GIS workflows. CityEngine also offers options for online stakeholder visualization, such as ArcGIS online, and exporting options that are convenient for more analysis or visualization in other software.

The 3D city model created in this study can support decision making in urban planning by providing an immersive virtual environment for city planners and stakeholders. The published web game, VR application, and mobile game offers platforms for the public to engage with urban design. Integrating VR and mobile games with urban design can enhance community participation since decision makers can perceive and interact with the scenarios virtually by walking or driving inside the Old Town.

This 3D model is capable of exporting statistics for selected objects to help city planners to quantify the current scenario of Old Town Pocatello. City planners can visualize and quantify the proportion of impervious surfaces that can cause serious environmental problem, such as water polluting, flooding, and heat island effects in Old Town Pocatello from Figure 4. The building-built year histogram displays the built year distribution for the building in Old Town Pocatello (Figure 5). City designers can use the histogram to find the buildings that are old and have low values to change into affordable housing or used for other purposes.

Although CityEngine is an effective software for building 3D models, there are some limitations, such as the complexity of building models for inexperienced users and the high cost of required computing resources and software licenses (Al-Douri 2006; Ahmed and Sekar 2015). Preparing data for 3D models is time consuming because 3D modeling requires more attributes in data to automate the model building process. For example, buildings need to have a roof type attribute; however, most of the building footprint data commonly available for most cities does not record roof type. When I assigned the real-world elevation to shapes and segments in the CityEngine, there were some pitfalls generated between shapes and segments. Without performing quality control checks, an avatar could get stuck in these gaps when they virtually explore the model using VR gear, which could cause game failure.

The 3D model for Old Town Pocatello in its current state can be used as a base model for building future scenarios. For example, city planners can select specific parking lots and change those parking lots into buildings in this 3D model using CGA rules. This 3D model for Pocatello Old Town can help city planners to visualize proposed development changes interactively. The workflow for developing a 3D urban model in this study is applicable in other cities for future sustainable development. In addition, the visualization products can be used as an education and outreach tool for K-12 to introduce and help K-12 students to gain a better understanding of remote sensing, geoscience, geographical information science, and programming. For future improvements, it would be time saving if developers can obtain the roof type and building height information from existing records instead of checking each building in Google Street View.

Chapter 4 Modeling Ecosystem Services for Pocatello, ID

4.1 Introduction

Urban expansion encroaches natural resources, which results in a decrease in Ecosystem Service (ES) values (Su et al. 2012). The Economics of Ecosystems and Biodiversity (TEEB) (2010) defines ES as the direct and indirect benefits from ecosystems to human beings. Synergies and tradeoffs often exist between ES (Foley et al. 2005; Power 2010). Human interactions try to maximize the benefits we can get from ecosystems by changing land use and land cover; however, it can also trigger tradeoffs between ES such that natural resources are negatively impacted (Dobson et al. 2006; Gasparatos, Stromberg, and Takeuchi 2011; Karp et al. 2013; Smith et al. 2013; Zheng, Fu, and Feng 2016).

Urbanization increases impervious surfaces and leads to environmental deterioration problems such as urban heat island (UHI) effects and increased flooding (Chen, Sun, and Niu 2019). Cities that experience UHI effects have higher surface temperatures than their surrounding rural areas due to the reduction in vegetation cover and an increase in impermeable surfaces in cities such as brick, concrete, and pavement (Solecki et al. 2005). Increasing impervious areas in cities can lead to a significant reduction in tree density because the impervious surfaces hinder tree establishment and the space between trees is reduced (Mcpherson, Nowak, and Rowntree 1994). Yang, He, Yu, et al. (2017) found that the thermal environment in Changchun, China increased dramatically as urban growth increased fourfold over the past 30 years. Similarly, Rogan et al. (2013) used Landsat TM thermal band data to study the relationship between LST and impervious urban surfaces in central Massachusetts where 30,000 trees were removed since 2008 due to urban sprawl. They compared the temperature variation over impermeable and permeable cover in urban areas and found that the temperature increased 10% after the trees were lost. Salt Lake City, a large city in the western U.S., has implemented programs to increase urban vegetation coverage to mitigate UHI effects (Solecki et al. 2005). UHI effects can also cause severe social impacts such as increased energy consumption, greenhouse gas emissions, and air pollutant concentrations (Selover and Steiner 2002; Sarrat et al. 2006).

Air pollution is a major environmental and health concern in most cities around the world (Nowak, Crane, and Stevens 2006; Nowak et al. 2013). Anthropogenic activities have aggravated air pollutants in cities with outputs of particulate matter, carbon monoxide, and nitrogen dioxide (Gopalakrishnan et al. 2018). Particulate matter (PM) contains solid or liquid materials that are suspended in the atmosphere; the size of such particles varies from 1 nm to 0.1 mm in diameter (World Health Organization 2005). Enviroment Protection Angency (EPA) assessed the risk level of $PM_{2.5}$ concentration and subsequently classified the level of $PM_{2.5}$ into six categories: 0 to 12 $\mu g/m^3$ indicates good air quality and has no risks to humans; 12.1 to 35.4 $\mu g/m^3$ is moderate; 35.5 to 55.4 $\mu g/m^3$ is unhealthy for senstive groups; 55.4 to 150.4 $\mu g/m^3$ is considered unhealthy for all groups; 150.5 to 250.4 $\mu g/m^3$ is very unhealthy; and 250.2 to 500.4 $\mu g/m^3$ is hazardous for all groups (Post et al. 2005). The American Lung Association reported (2016) that there were a minimum of 16 million people in the U.S. who live in areas with high levels of air pollutants with road traffic alone accounting for over 66% of $PM_{2.5}$ emissions. Green infrastructure, such as trees and a green roof, can decrease $PM_{2.5}$ concentration from traffic emissions through dry deposition (Jeanjean, Monks, and Leigh 2016). Nowak, Crane, and Stevens (2006) found that trees can remove about 711,000 metric tons of air pollutants annually in the continuous U.S., saving an estimated $3.8 billion. Yang, Yu, and Gong (2008) quantified the air pollutants removed by green roofs in Chicago and found out that in one year 1675 kg of air pollutants were removed by 19.8 ha of green roofs.

It is important to understand what human interactions, design, planning, and management methods can contribute to our understanding of urban regions (Breuste and Qureshi 2011). Remote sensing (RS) and Geographical Information Science (GIS) are two useful tools to study the pattern of land cover and land use changes due to urbanization effects at different spatial and temporal scales (Su et al. 2012). In this chapter, I built a future green scenario by increasing green space areas and the number of trees for Pocatello Idaho in ArcGIS Pro. There were two ecosystem service models created for simulating and evaluating the impacts on thermal regulation and air pollutants concentration in this green scenario. The models created in this chapter can display heat island effect and air pollutant concentration using before and after scenarios of present condition and simulated change. The two models created in this chapter are applicable to other areas by adjusting input datasets.

4.2 Methods

4.2.1 Study Area and data sources

The research area was Pocatello, Idaho. Pocatello is located in Southeast Idaho (42°52′30.8″N 112°26′50.2″W). The total area of the study area in this Chapter is 5885.6 ha as shown in Figure 13. Pocatello has a semi-arid climate with long, cold winters and hot, dry summers (Peel, Finlayson, and McMahon 2007). The population of Pocatello was 55,193 in 2017, according to a US Census Bureau survey.

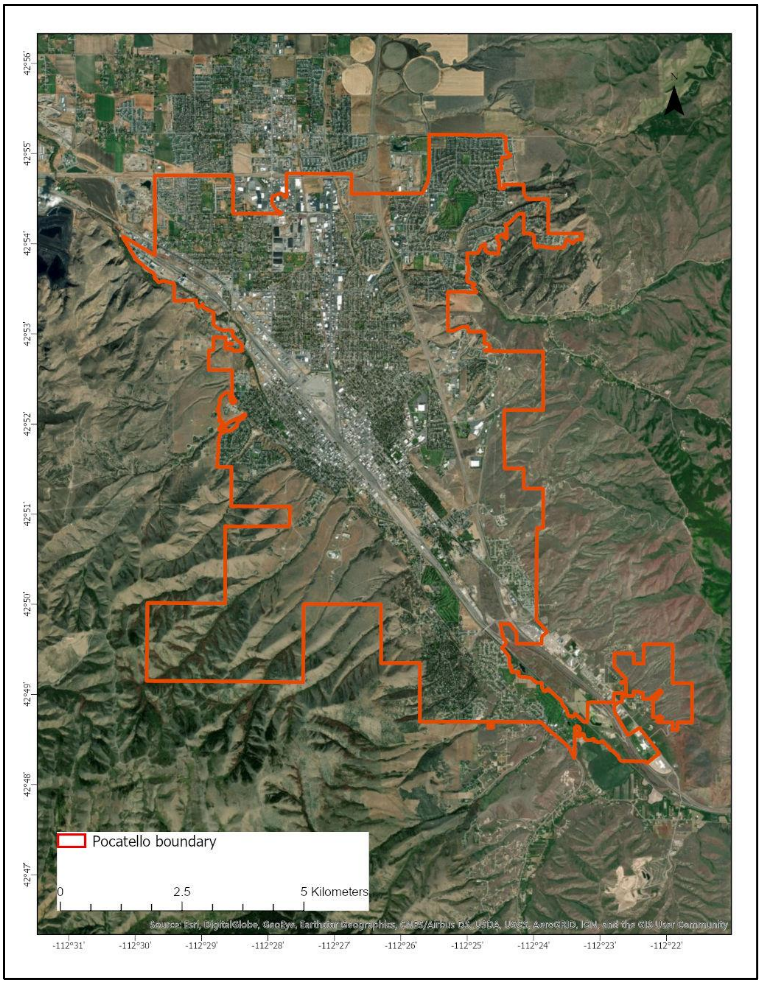

Figure 13. City Limits of Pocatello (2018)

The data for retrieving LST and modeling thermal regulation was from Landsat 8 satellite images taken on August 1st, 2018 and downloaded from the United States Geological Survey (USGS) EarthExplorer online search tool. In addition, I carried an in-situ AEROCET 831 handheld particle counter to monitor air quality. It is a small, lightweight, battery-operated unit that measures real-time mass concentrations of PM_1, $PM_{2.5}$, PM_4, PM_{10}, and total suspended particle (TSP). The AEROCET 831 uses a proprietary algorithm to calculate count data to mass measurements in ug/m^3 (Met One lnstruments 2014). Tree data was obtained from the City of Pocatello's 2018 tree inventory. The tree survey started in May 2018, and it is still in progress.

Therefore, the tree dataset used in this chapter was a preliminary dataset for Pocatello. The attributes in this tree inventory included tree diameter at breast height, tree name, species, etc. The software used to process and visualize this data and results was ArcGIS Pro and ENVI.

4.2.2 Land surface temperature

Avdan and Jovanovska (2016) created an algorithm to retrieve LST from the Landsat 8 dataset using thermal band 10, near infrared band 5, and red band 4 (Figure 14). Following their workflow, the first step was to convert the digital number (DN) value of band 10 into top of atmospheric (TOA) spectral radiance. The next step was to transform the TOA into brightness temperature (BT). Since each land use type has a different effect on LST, it was necessary to correct and calculate land surface emissivity using normal difference vegetation index (NDVI) values. The last step was to estimate land surface temperature based on BT and land surface emissivity. More information and parameters, such as thermal conversion constants, for retrieving LST can be found in (Avdan and Jovanovska 2016).

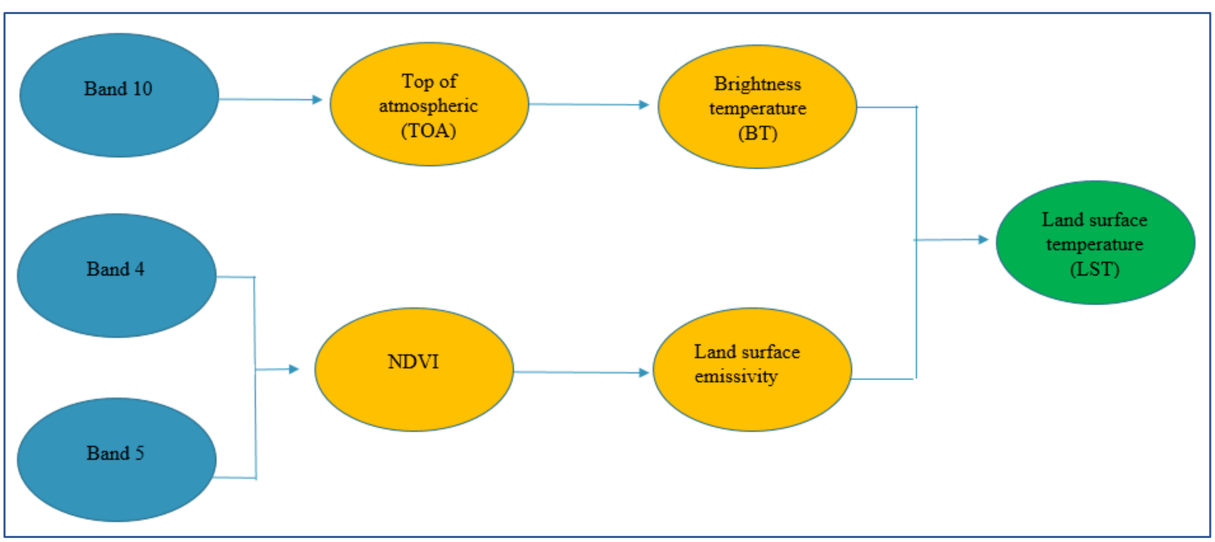

Figure 14. Land surface temperature retrieving workflow.

Source adapted from: (Avdan and Jovanovska 2016).

4.2.3 Heat island effect

Since buildings and paving materials, have low albedo, the temperature in urban areas is higher than its surrounding vegetated surfaces (Imhoff et al. 2019). The heat island effect can be calculated by brightness temperature (BT) (Fang 2015) as shown in equation (2):

$$N = \frac{BT_i - BT_{min}}{BT_{max} - BT_{min}} \quad (2)$$

Where, N is the normalization of BT in pixel i, and BT_{max} and BT_{min} are the maximum and minimum BT, respectively. We can use N value to categorize the degree of heat island effect into five zones: strong heat island zone (0.8-1.0), heat island zone (0.6-0.8), normal zone (0.4-0.6), green island zone (0.2-0.4), and strong green island zone (0-0.2) (Fang, 2015).

4.2.4 Normalized difference vegetation index (NDVI)

NDVI is the most common vegetation indicator to detect vegetation coverage on land surfaces (Karnieli et al. 2010). The theory behind NDVI calculation is that the maximum absorption of radiation in red spectral and maximum reflection in near infrared spectral are different in vegetation, as shown in equation (3) (Tucker 1979; Karnieli et al. 2010). I obtained NDVI using red and near infrared bands from the Landsat 8 ARD dataset.

$$NDVI = \frac{NIR - Red}{NIR + Red} \quad (3)$$

4.2.5 Air pollutant removal

For simulating airborne contaminant removal, I used stratified random sampling to collect particulate matter samples during the growing season from April 15th to June 20th, 2019. The sampling method is shown in Figure 15. There were thirty sampling points in Pocatello. Due to limited accessibility, I selected sites that were close to the software-generated random points. The inputs used to generate random points was the zoning map of Pocatello. Three zones were used as the stratums: commercial, parks/open space, and residential zones. Each zone had 10 random points generated by the Create Random Points tool in ArcGIS Pro. The last step was to interpolate total suspended particulate (TSP) concentrations for the entire study area using the Empirical Bayesian Kriging tool in ArcGIS Pro.

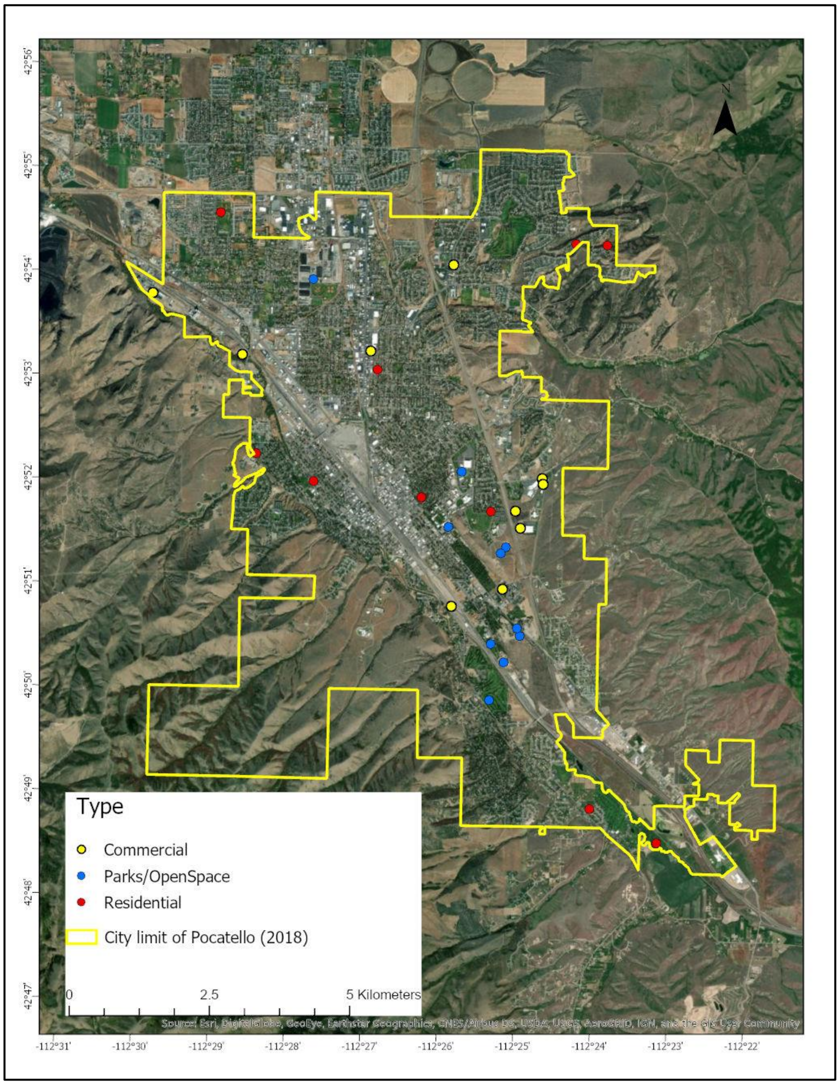

Figure 15. Particulate matter sampling method.

4.2.6 Air pollutant removal modeled and monetary values

The removal of a particulate air pollutant at a given place over a certain time period can be calculated as follows: (Mcpherson, Nowak, and Rowntree 1994; J. Yang et al. 2004)

$$Q = F * L * T \qquad (10)$$

Where Q is the amount of a particulate air pollutant removed by trees in a certain time, F is the pollutant flux, L is the total canopy cover in that area and T is the time period. In this case, the range of L values for the proposed trees in the green scenario varies from 5 to 35 sqm^2 for estimation. T is the growing season is from April 15^{th} to June 15^{th} in 2019. The pollutant flux is calculated as:

$$F = V_d * C \qquad (11)$$

Where V_d is the dry deposition velocity of a certain air pollutant, and C is the concentration of one air pollutant in the air. The average dry deposition rates for particulate matter is 0.64 m/s is shown in Table 4.

Table 4. Typical range of deposition velocity for air pollutants on tree canopy.

Air pollutant	Site of deposition	V_d range (cm/s)	V_d average (cm/s)
SO_2	Exterior surfaces and interior of leaves	0.2-1.0	0.55
NO_2	Primarily interior of leaves, also exterior surfaces	0.1-0.5	0.37
Particulate	Exterior surfaces and interior of leaves	0.5-2.0	0.64

Particulate matter not only can be removed through a dry depostion process on trees, but also can be removed by rain fall (Nowak et al. 2018). Rain can wash the total suspended particles (TSP) on the leaves and branches to the ground to purify the air. Nowak et al. (2013) states that the resuspension percentage for total suspended particulate (TSP) varied with wind speed and species. The wind speed data in Pocatello was downloaded from the National Climatic Data Center. The resuspension percentage by wind speeds between 0 m/s and 13 m/s were estimated using a linear regression method (Table 5). When precipitation exceeded the canopy storage capacity (0.2 * LAI), the accumulated particulate matter was assumed to be washed off the leaf and landing on the ground (Gopalakrishnan et al. 2018). LAI is the total leaf area index per unit of tree cover. The source of LAI data used in this chapter was MODIS/Terra global LAI with 1 km resolution.

Table 5. The resuspension percentage by wind speed (Nowak et al. 2013).

Wind speed (m/s)	0	1	2	3	4	5	6	7	8	9	10	11	12	13
Resuspension (%)	0	1.5	3	4.5	6	7.5	9	10	11	12	13	16	20	23

The deposition process is more effective during the growing season when the stomata are open (Jim and Chen 2008). In this study, I used the deposition rates in growing seasons to estimate the annual deposition rate for each air pollutant. I also calculated the amount of particulate washed off from precipitation during this period. Since a 912 metric ton decline of particulate matter results in 1 billion U.S. dollars in benefits, according to the EPA, I calculated monetary benefits from particulate removal in the proposed scenario using EPA standards (Batkins 2016).

4.2.7 Regression analysis and prediction

In this chapter, a green scenario was proposed for Pocatello with more green space and trees, as shown in Figure 16. In the proposed scenario, the trees were planted in places suitable for planting according to i-Tree modelling. i-Tree is a software suite, developed by the USDA Forest Service, consisting of a set of tools that can quantify the ecosystem service benefits of trees across parcels, neighborhoods and cities (i-Tree 2019). The proposed trees that can be planted in Pocatello from an i-Tree model has a PPA_V_Pct attribute, which is the percentage of possible planting area for vegetation ranging from 0 to 100. If the areas were covered by roads, they were considered unsuitable for planting. I selected the trees with planting suitability between 50 and 100 percent yielding 6990 trees. These 6990 trees would be planted in the proposed future scenario. The average cost for a tree in Idaho is approximately 45 U.S. dollars, according to a report from the Pocatello Chamber of Commerce (https://www.chamberofcommerce.org/christmas-tree-pricing/#christmas-tree-prices-in-the-us). To add more green spaces, I replaced impervious parking lots with green parking lots (269.9 ha). In the green scenario, I also replaced the vacant rail yard in the center Pocatello with green grass (51.7 ha). The green parking lots are defined as turf-based parking lots made of concrete or plastic grids and grass providing aesthetic and environmental benefits in urban areas (Volterrani et al. 2001). The cost of turf-based parking lots is between 41 and 48 U.S. dollars per square meter in Pocatello at 2019 prices, according to Remodeling Expense (https://www.remodelingexpense.com/costs/cost-of-turf-blocks/)

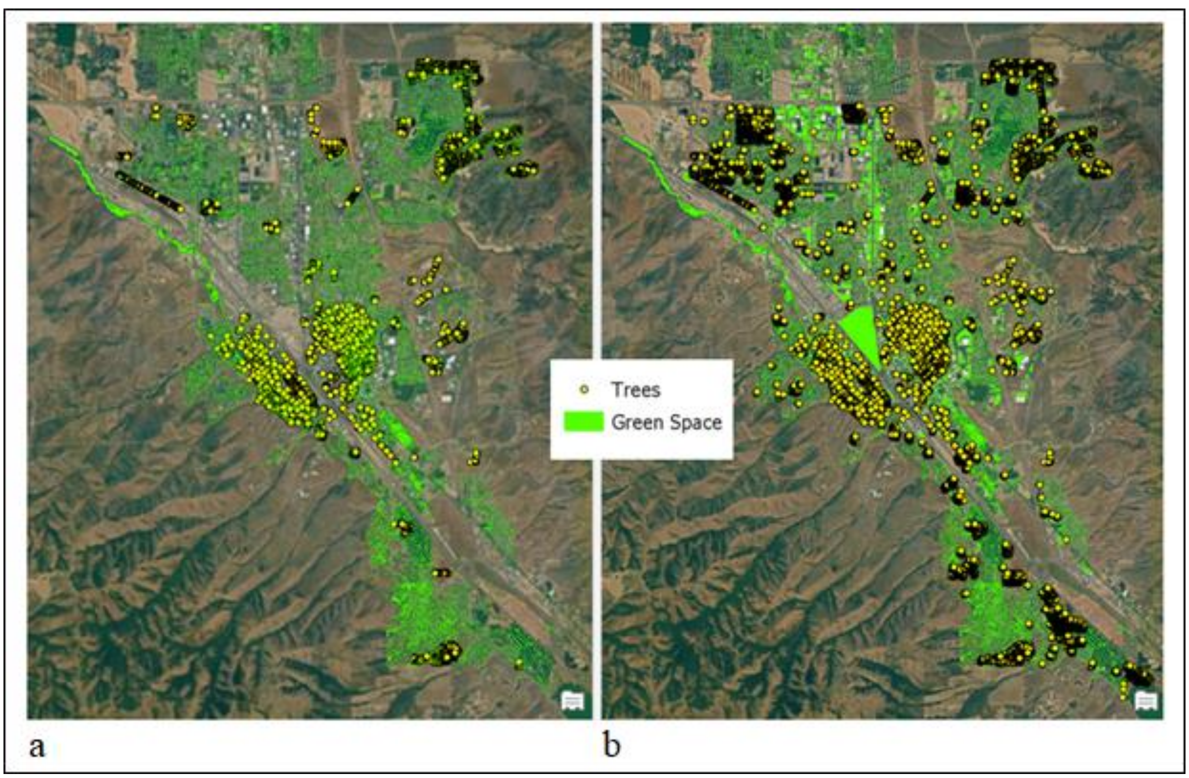

Figure 16. Current and proposed scenario in Pocatello, ID.
a. Scenario 1 with 4646 trees and 2287.3 ha green space.
b. Scenario 2 with 11,636 trees and 2,608.9 ha green space.

There were two regulating ecosystem services modeled in the proposed scenario: the impacts on local surface temperature in summer from green parking lots, and the influences on particulate matter concentration from added trees in the proposed scenario. To predict the impacts on LST in the proposed scenario, the first step was to explore the relationship between LST and NDVI using 2D scatter graphs. The dependent variable was LST, and the explanatory variables was NDVI. The assumption for estimating LST in the green scenario was that the green parking lots would have similar impacts to LST as local irrigated grass since they have a similar coverage. Hence, I gave the mean NDVI value of irrigated grass to the proposed green parking lots. The next step was to run the EBK regression analysis to predict the LST in the new scenario. Lastly, the monetary value saved by trees in the future scenario was estimated. The saved monetary value of the amount of particulate matter that can be removed by trees in the proposed scenario from mid-April to mid-June was calculated according EPA standards set in 2018.

4.3 Results

4.3.1 Land surface temperature

There was a negative relationship between NDVI and LST with an R^2 value of 0.57 (Figure 17). The degree of heat island effect ranged from 0.63 to 0.92 on August 1st, 2018 as shown in Figure 18. The LST comparison map between the current and predicted scenarios is shown in Figure 19. Red areas indicated higher surface temperature, and yellow areas indicated lower surface temperature. The current mean LST in Pocatello was 35.8 °C and the predicted LST was 35.6 °C on August 1st, 2018. There was a 0.2 °C reduction in the proposed scenario. There were 1280 parcels with land cover change in the green scenario (Appendix E). Figure 20 displays the comparison of impervious percentage by parcel between current and proposed scenarios. The mean land surface temperatures for the parcels with land cover change in the current scenario and green scenario were 36.4 °C and 35.8 °C, respectively. There was a 0.57 °C decrease in the green scenario. Similarly, like the surface temperature map, red indicates high impervious areas and yellow shows the low impervious areas. The total area of replaced green spaces in the proposed scenario was 2,698,624 m^2 and the corresponding cost for turf-based parking lots was between $110 million and $129 million U.S. dollars in 2019.

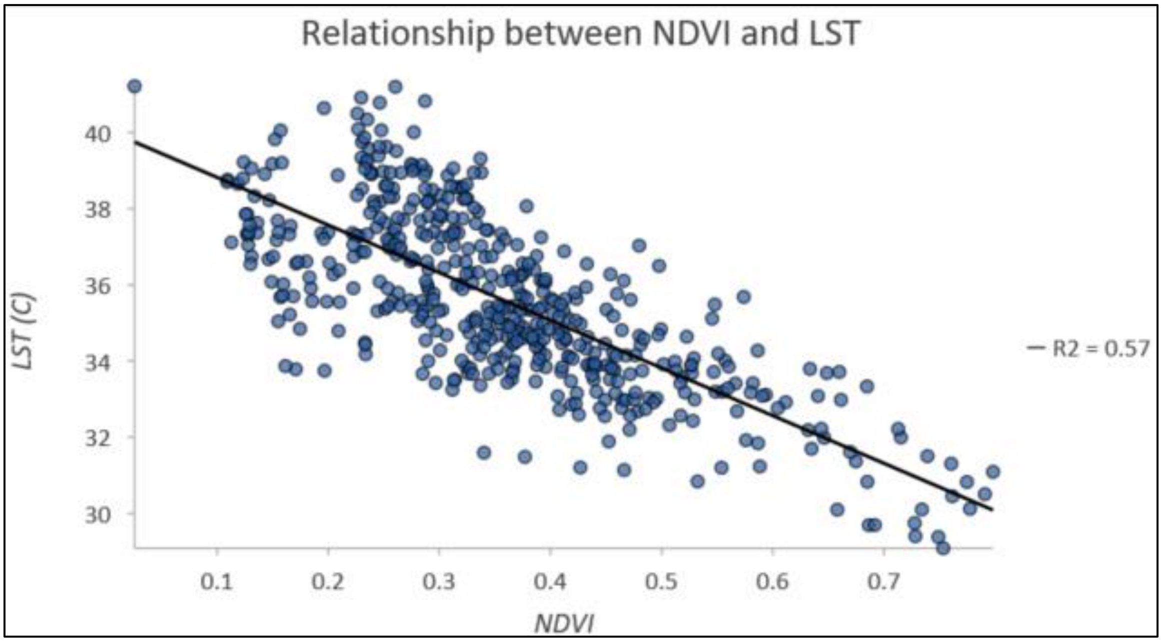

Figure 17. Linear relationship between NDVI and LST.

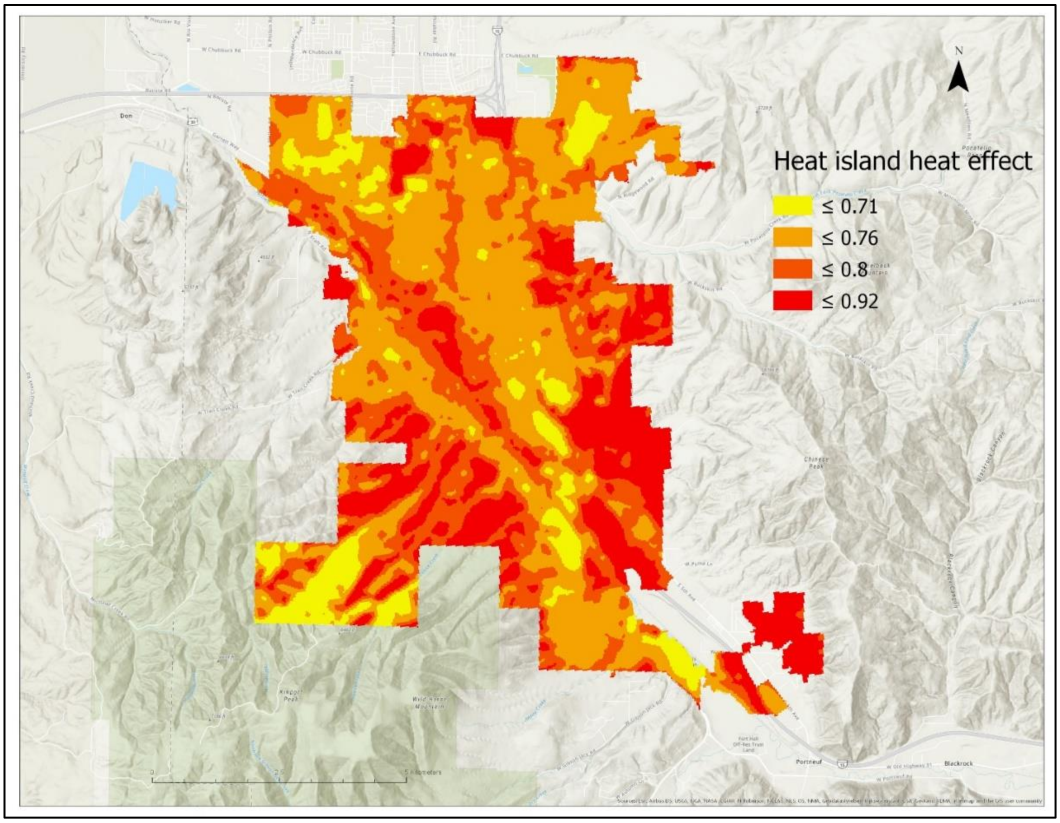

Figure 18. Heat island effect in Pocatello on August 1st, 2018

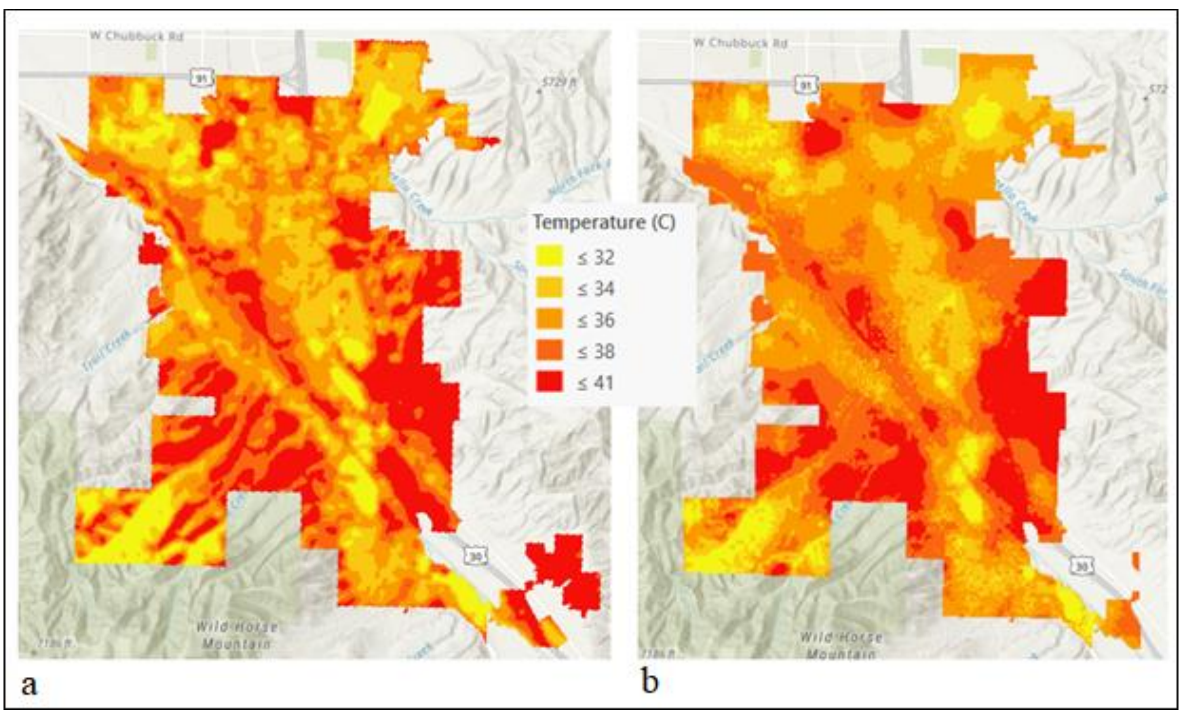

Figure 19. Heat island effect in current and predicted scenarios in Pocatello, ID.

a. Heat island effect in the current scenario. b. Heat island effect in the predicted scenario.

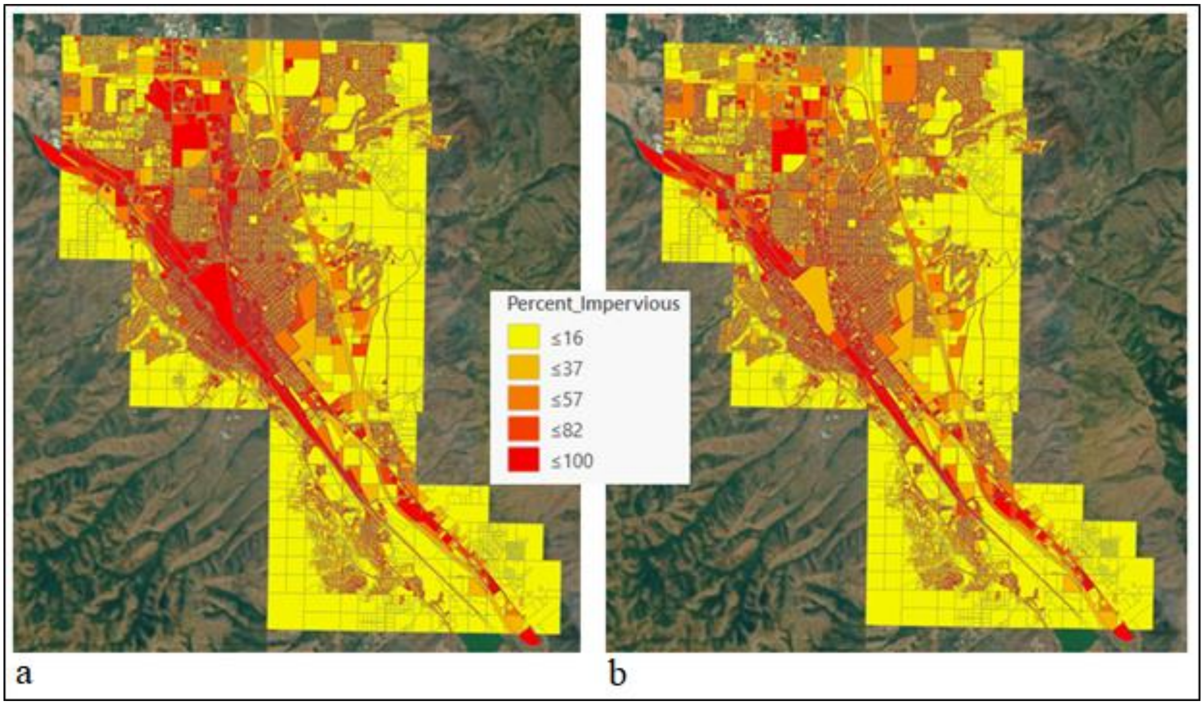

Figure 20. Impervious percentage by parcel in current and predicted scenarios in Pocatello, ID

4.3.2 Air pollutants removal

There were 150 total sample points covering Pocatello, ID. The daily TSP concentration for April 15th, 22th, 29th, May 21st, June 7th, and 20^{th,} 2019 are shown in Figure 21. April 15th, 29th, and June 20th had more particulate matter than other days. The northwest region had higher TSP than other areas. Figure 22 shows the average daily TSP concentration during this period. The maximum TSP concentration was 311.3 ug/m^3, and the minimum TSP concentration was 2.2 ug/m^3 with an average TSP concentration of 21.9 ug/m^3.

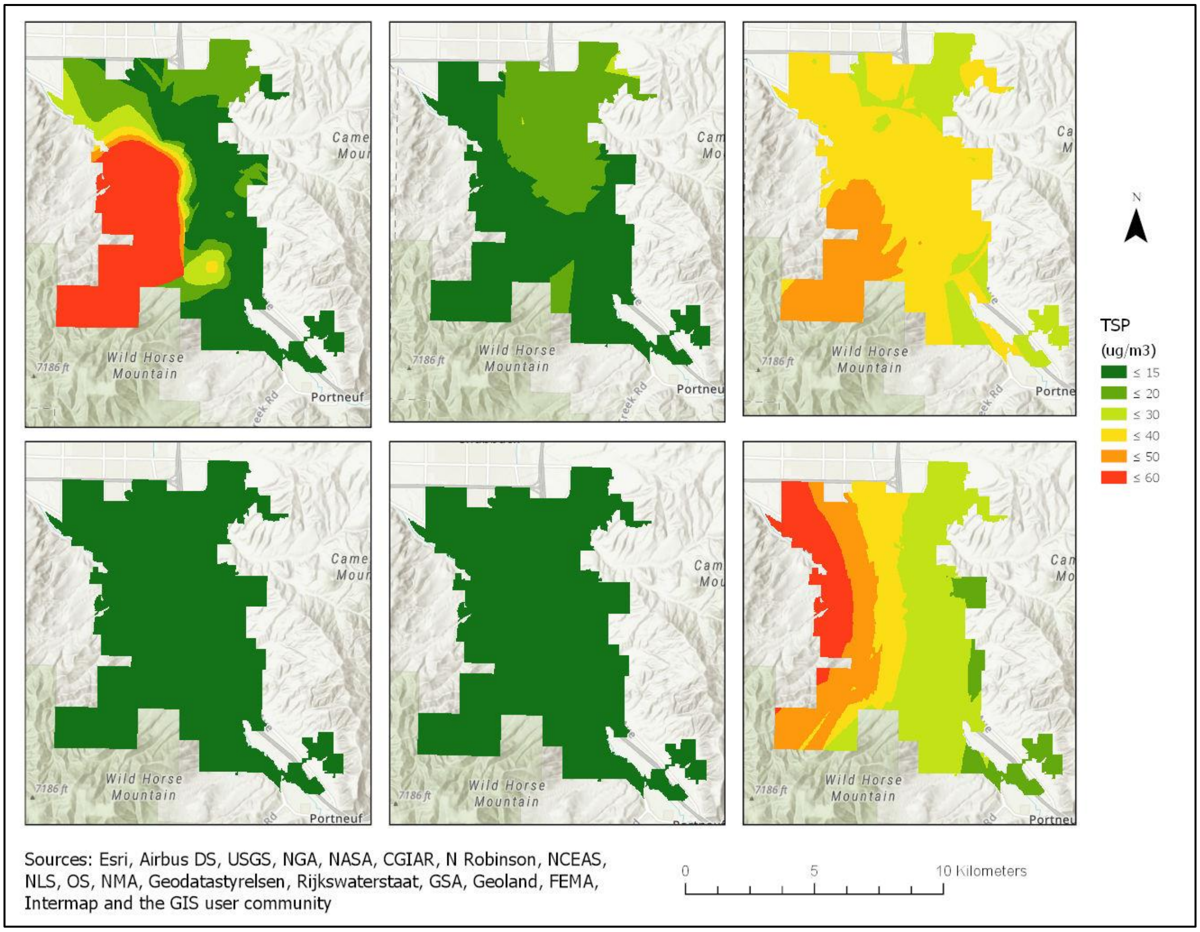

Figure 21. Daily TSP concentrations on April 15th, April 22nd, April 29th, May 21st, June 7th, June 20th, 2019 (from left to right; from top to bottom).

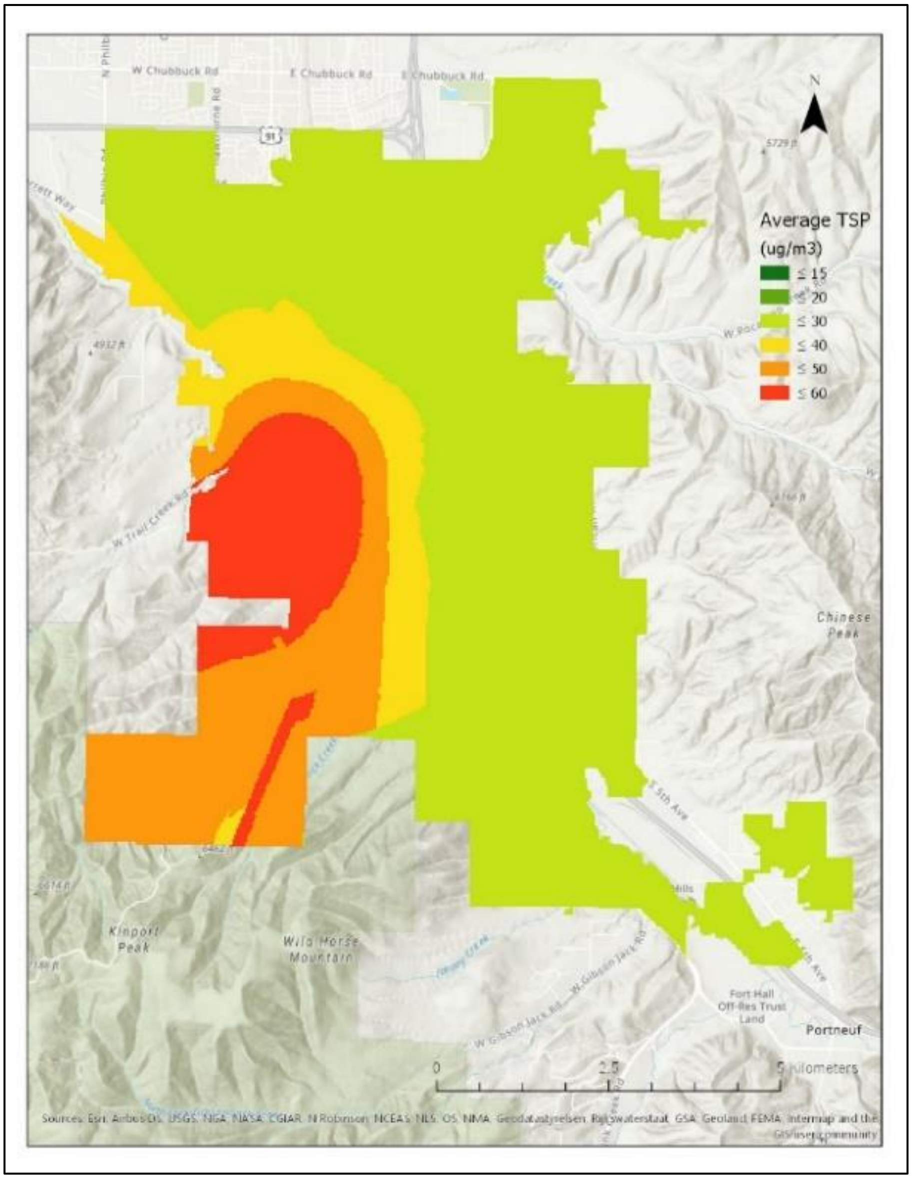

Figure 22. Average TSP concentrations from April 15th to June 20th, 2019.

There was a linear relationship between wind speed and resuspension percentage with R^2 value of 0.96 (Figure 23Figure *23*). The linear equation was y=1.5835x- 0.5429. The local resuspension percentage was calculated using the above equation with the results shown in Table 6. The TSP resuspension percentage varied from 2.9% to 10.7%. The average wind speeds ranged from 2.2 m/s to 7.1 m/s. The maximum wind speed and resuspension percentage during this period was on May 17th, as shown in Table 6.

Table 6. Average wind station and resuspension percent for particulates in Pocatello.

STATION	NAME	DATE	AWND (m/s)	Resuspension (%)
USW00024156	POCATELLO REGIONAL AIRPORT, ID US	5/17/2019	7.1	10.7
USW00024156	POCATELLO REGIONAL AIRPORT, ID US	5/19/2019	2.9	4.0
USW00024156	POCATELLO REGIONAL AIRPORT, ID US	5/21/2019	4.4	6.4
USW00024156	POCATELLO REGIONAL AIRPORT, ID US	5/22/2019	5.9	8.8
USW00024156	POCATELLO REGIONAL AIRPORT, ID US	5/24/2019	4.8	7.1
USW00024156	POCATELLO REGIONAL AIRPORT, ID US	5/27/2019	2.2	2.9
USW00024156	POCATELO REGIONAL AIRPORT, ID US	5/28/2019	4	5.8

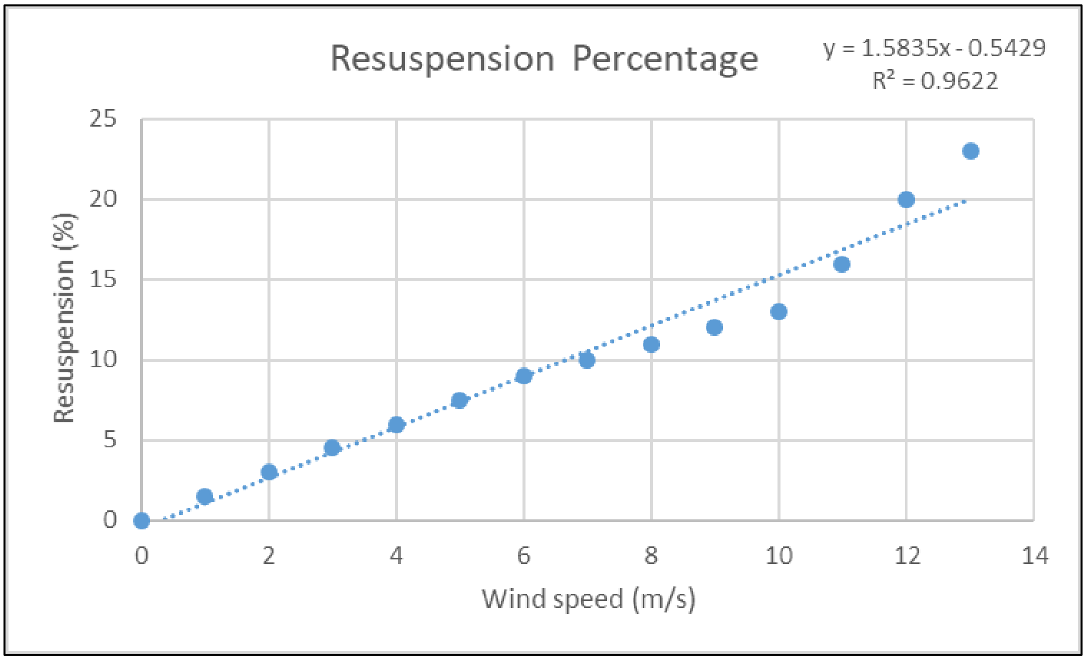

Figure 23. Linear relationship between resuspension percentage and wind speed.

There were six rainy days that were heavy enough to wash-off particulate matter from leaves and branches between April 15th to June 15th, 2019. The amount of particulate matter removed from rainwater wash-off was 3.65 g. The amount of particulate removed through dry deposition was 117,635.86 g. Trees in the future scenario could remove up to 0.12 metric tons in total over these 62 days. The corresponding saved monetary value for the removed air pollutants was $11,200 in 62 days. Thus, the daily average amount of particulate matter that can be removed by the trees in the proposed scenario is 0.002 metric ton per day. To estimate the amount of particulate matter removed by trees annually, I calculated the average amount in spring and summer since dry deposition process only occurs during the tree growing season of approximately 6 months or 180 days. In this case, the proposed trees can remove up to 0.36 metric ton annually. The estimated saved monetary value from trees would be $317,333 in 10 years. The number of trees in the proposed scenario was 6990, so the cost for the trees was $314,550 U.S. dollars in 2019.

4.4 Discussion

According to the current heat island effect result (Figure 18), the range of the UHI is from 0.71 to 0.92. Thus, the Pocatello area was either in heat island zone or strong heat island zone on August 1st, 2018. The LST varied based on land cover. Land surface temperature was predicted based on NDVI. The areas with high NDVI value have lower surface temperature. The NDVI value for vegetated areas in Pocatello on August 1st, 2018 was around 0.6. Concentrated impervious surfaces have low NDVI values that are about 0. Thus, concentrated impervious areas, such as rail yards, streets, building complexes, and impermeable parking lots, have higher surface temperatures than vegetation and water bodies. Although the mountain areas that are close to Pocatello city center region have vegetated coverage, they had a high surface temperature on August 1st, 2018 since they are composed of sagebrush and senesced cheatgrass with low NDVI values (around 0.3). Replacing impervious parking lots with green parking lots can mitigate local heat island effects. Thus, green space is an important contributor to reducing surface temperature in urban areas. The impervious percent by parcel also decreased (5.3%) in the new scenario, where I proposed to plant more trees (6990) and to switch impervious parking lots into green parking lots (269.9 ha), especially in the Old Town area (129.2 ha), as displayed in Figure 20. In the current scenario, the area with high impervious percentages reported higher surface temperatures. For example, the vacant rail yard in the center of Pocatello and businesses clustered region in northern, northwestern, and Old Town Pocatello had a higher surface temperature (29.6° to 42.0 °C) compared to other areas. Therefore, impervious surfaces can increase urban surface temperature, whereas green spaces can mitigate a urban heat island effect.

To prevent urban heat island effect in Pocatello from increasing, adding green spaces is an effective method to mitigate UHI effects. Other options also exist for reducing UHI effect. For example, Los Angeles, California planned to paint their roads with a white seal coat to mitigate UHI effects ("New Light Roads Covering Los Angeles – The Truth about ' White ' Streets" 2018). Painting streets with a lighter color seal coat can be added to the proposed Pocatello scenario to examine its effects on LST. This is a method recommended for further testing in the model.

Trees can consistently re-suspend particulate matter in dry seasons that vary based on wind speed (Nowak et al. 2018). Higher wind speeds lead to higher resuspension percentages for particulate matter in urban trees. The daily TSP concentration showed that there was less particulate matter from late May to early June due to rainfall. The resuspended particulate matter in trees would be washed off by rainwater into the soil (Nowak et al. 2018). TSP concentration increased after rains on June 20th, 2019.

Northern and western Pocatello had higher particulate matter deposition than other regions. The sources for particulate matter are suspected to be derived primarily from human activities, such as agriculture, traffic emissions, and road/soil dusts (Zhang and Cao 2015). The higher TSP concentration in northern and western Pocatello can be explained by local climate, soil deposition, agricultural operations, topography, and the leeward-facing topography of this part of Pocatello. Its semi-arid climate plus frequent dust storms are explanatory factors that may contribute to this effect (Csavina et al. 2014) as northern Pocatello is the warmest and driest area in Bannock County Idaho (USDA 1987).

Arbon Valley is on the west side of Pocatello in Power County, and the primary activities are farming and ranching (USDA 1981). Intensive agricultural activities from tractor and farm equipment related soil disturbance create emissions and dusts during the growing period of April to June. The main soil type in Arbon Valley is silty loams (USDA 1981). The most often average wind direction in Pocatello from March to July is from the west recorded at the Pocatello Regional Airport ("Average Weather in Pocatello" 2019). Thus, winds blowing from northwest to southeast carry particulates from the Arbon Valley area, climbing to Howard mountain and then drop the particulates to the leeward side of Howard in western Pocatello. In addition, most industries are gathered in northwestern Pocatello, which also accounts for added particulate matter.

To demonstrate the thermal regulation model, I modeled LST for Pocatello in 2018 using Landsat 8 ARD dataset. A specific date (August 1st, 2018) was chosen to predict UHI because UHI effects normally occurs on hot summer days. Due to dataset limitations, there was only one image that covered the whole study area and had less than 10% cloud coverage. For future research, a larger dataset is needed for more accurate modeling. The predicted mean surface temperature was estimated from Landsat 8 images that were acquired at a 11:12 am (Mountain Time) on August 1st, 2018. Thus, to improve the accuracy of LST predictions in the proposed scenario, the mean surface temperature from field measurements would be required to match the imagery. For the air pollutant removal model, I used a preliminary tree dataset that is not representative of all the trees currently planted in Pocatello. However, the model created in this study readily facilitates updates to the tree input layer and can be re-run once the completed dataset is available. The urban thermal regulation and air quality regulation models in this chapter estimated the amount of particulate matter that can be removed by urban trees. Green parking lots have potential to clean the air and remove particulate matter as well. However, there is no consistent approach to appraise the amount of particulate matter that can be removed by grass and thus it was not included in the model estimation.

The thermal regulation model and air pollutant removal model can help us to visualize the variation across the study area and changes of before and after scenarios. These two models also provide us with statistical results such as reduced LST and the amount of particulate matter that can be removed. Other researchers can use these two models to analyze their area of interest by changing input data. These ecosystem service models can help city planners to visualize and quantify the impacts of local ecosystem services from different scenarios. Ultimately, this approach can assist planners and stakeholders to realize sustainable city growth.

Chapter 5 Conclusion

The City of Pocatello have been looking at the opportunities for redeveloping the Old Town area. For instance, they would like to add more green spaces to the Pocatello Old Town and to make Old Town area more accessible to residents. Chapter 3 provided city planners a workflow and a 3D city model product using procedural modeling approach to visualize and quantify different designs. This approach can assist planners to visualize the changes and engage stakeholders on redevelopment opportunities through visualization. The visualization products (WebGL, VR, and Android mobile games) can be used as geoscience education outreach tools for K-12. Besides improving visualization and quantify statistics (e.g. landcover type percentage) in different scenarios, it is necessary for city planners to understand the impacts on local ecosystem services from different scenarios to obtain a sustainable growing city. There were two ecosystem services models introduced in Chapter 4 that are Urban thermal regulation model and air quality regulation model. Urban heat island effect can increase energy consumption, and air pollutants (e.g. particulate matter) can cause direct harms to human health.

Chapter 3 described the process for creating a 3D city model using a procedural modeling approach in Old Town Pocatello. To foster public participation in urban design, a 3D model with VR and a mobile game were also developed. Conventional 2D urban design is a common approach in the urban planning field. However, 3D modeling can enhance spatial visualization. Procedural 3D modeling has solved time-consuming problems more rapidly when compared to conventional 3D modeling approaches. Procedural 3D modeling is an effective method for building 3D city models. Procedural modeling can create and re-generate 3D objects using grammar-based rules. However, licenses for 3D modeling software are still expensive and complicated for beginning users.

In this thesis, I used CityEngine software to create a model for Old Town Pocatello, Idaho. CityEngine is an Esri software product, so there are no barriers to import GIS data from ArcGIS Pro or ArcGIS, a commonly used software in many counties and cities. CityEngine is a relatively new software for 3D procedural modeling that is limited by a lack of geospatial analysis tools. To overcome this problem, customized Python scripts were created such as an exporting script, a select by attributes script, reporting script, and generating new scene script (Appendices A-D).

To explore the development of visualization tools that have the potential to encourage public participation in urban planning and design, I built a VR application, a web game, and an Android mobile game using the Unity gaming development platform. In the VR application, developed for the HTC Vive, users are immersed in a virtual Old Town Pocatello. They can control their movement using a touchpad to walk inside the virtual environment. To reach a broader audience the VR application developed for the HTC Vive can also be ported to a web page for potential users to access. The online web game is “Take a walk through the Old Town Pocatello.” This online web game can provide users with a real-world scene of Old Town Pocatello including buildings, streets, trees, people, cars, etc. It is capably of helping users to virtually walk through Old Town Pocatello. Residents can visualize the urban layout in the Old Town area and can possibly propose redeveloping ideas to planners. For the Android mobile game, users can control a car using a joystick to drive through Old Town Pocatello. Creating VR products has the potential to enhance community participation in the urban design process and can help decision makers to visualize different planning scenarios and thereby devise a better plan. This thesis provides examples of three VR products produced for Old Town Pocatello that could be developed for other cities.

In chapter 4, I studied the influences on local ES from urban sprawl and human activities and modeled the impacts on ES in a potential future ES scenario in Pocatello, Idaho. In the new scenario, two urban planning initiatives were proposed for Pocatello: (1) switching impervious parking lots into green parking lots and (2) planting more trees. Urban trees can clean air quality through dry deposition and resuspension and with more green spaces can reduce land surface temperatures (LST) or Urban Heat Island effects. LST in cities has increased due to human activities and construction. I modeled current LST in Pocatello based on Landsat 8 ARD dataset on August 1st, 2018. Most of the temperature hot spots appeared on impermeable concrete areas, such as parking lots and buildings. The LST over the Portneuf River and parks was lower than other surfaces in Pocatello. The results show that there was a negative relationship between NDVI and LST. Higher NDVI values, which indicate healthy vegetation coverage, have a lower surface temperature. Based on this relationship, I ran an interpolation tool to predict LST. Increasing green space does mitigate temperature hot spots and decreases local average surface temperature. The increasing vegetation coverage from green parking lots also changes the impervious surface percentage in Pocatello. To visualize impervious surfaces and the impact of converting to green parking lots and planting more trees in Pocatello area, I created a before and after map that showed impervious percentage for each parcel in Pocatello (Figure 20). I also modeled the amount of particulate matter that can be removed from trees in the new scenario and its associated monetary savings against the cost of planting additional trees.

To examine real-world total particulate distribution in Pocatello, I measured the total particulates concentration once a week from mid-April to mid-June 2019 (6 dates) using a portable air quality monitor across residential, commercial and green space locations in Pocatello. I mapped the total particulate concentration in Pocatello for the 6 dates and produced a time series map to reveal changes in particulate matter concentrations across the city. The particulate concentration was lower after rains since precipitation washed-off re-suspended particulates into the soil. The total particulate concentration in northern and western regions is higher than other areas in Pocatello due to agricultural activities in the Arbon Valley, industries in northwestern Pocatello, wind direction and speeds, a semi-arid climate, and local topography.

The value, relationship, and role of ES has been studied in many papers (Manes et al. 2017). However, few of them combine 3D urban models with ES. This study demonstrates an efficient method to create 3D city models using a procedural modelling approach. The 3D urban models and visualizations created in this study can help planners, stakeholders, and communities to envision Pocatello Old Town in its current state and in alternate future planning scenarios. The voices and opinions from residents for city development are important to city planners. The VR, web, mobile applications encourage participation from residents. The VR, web, and mobile applications also can be used for presenting future possible scenarios. These tools enable, city planners and stakeholders to gather more ideas and feedback from the public and revise development plans accordingly.

This study also examined the impacts on Pocatello ecosystem services in a possible scenario that increased green space and trees. I created models for evaluating the changes and monetary savings in ES. The models can help to raise public awareness of the relationship between urban development and ES. Therefore, it is likely to help city planners and stakeholders find a balance between urban infrastructure and sustainable urban ecology. Due to data and time limits, there were only two ES scenarios modeled for heat island effects and for air pollutant removal.

The methods used in this study are applicable to Pocatello and other cities for urban planning. The 3D urban model in this study covers the Pocatello Old Town area as a demonstration. The City of Pocatello can expand the model extent to their area of interest. Other cities can also build 3D models using their input datasets. In addition to urban heat island effects and air pollution removal, city planners and stakeholders can model and visualize any ES change that they are interested in.

Future improvements will be to integrate modeled ES with the 3D urban model and publishing it as an interactive web application. Combining modeled ES and its corresponding cost and benefits in possible scenarios with 3D procedural modeling can improve urban design both visually and statistically. The interactive web application will have a 3D viewer that displays different scenarios and a slide bar that shows values and relationships for different ecosystem services. This web application will be a geodesign tool that helps planners and stakeholders to visualize different scenarios and impacts on local ES. In this case, this geodesign tool could help cities to grow in an ecosystem friendly way.

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Appendix A – Export selected objects Python Script

```
ce = CE()
REPORT = ""
def initExport(exportContextOID):
    global REPORT
    REPORT = "Property Type,Year Built,Gross Floor Area,\n"
def finishModel(exportContextOID, shapeOID, modelOID):
    shape = Shape(shapeOID)
    model = Model(modelOID)
    global REPORT
    reports = model.getReports()
    if reports['Property Type']!=None:
        PT=str(reports['Property Type'][0])
    else:
        PT="Null"
    if reports['Built']!=None:
        YB=str(reports['Built'][0])
    else:
        YB="Null"
    if reports['Gross Floor Area']!=None:
        GFA=str(reports['Gross Floor Area'][0])
    else:
        GFA="Null"
    REPORT +='{0:2d} {1:3d} {2:4d} \n'.format(PT, YB,GFA)
def finishExport(exportContextOID):
    file = ce.toFSPath("models"+"/instanceMap.txt")
    FILE = open(filename, "w")
    FILE.write(REPORT)
    FILE.close()
```

Appendix B – Select by attributes Python Script

```
# Get a CityEngine instance
ce = CE()
# Select buildings by built year
def SelectBuildingsByYear(YearBuilt):
   objects = ce.getObjectsFrom(ce.scene())
   selection=[]
   for o in objects:
        attrvalue = int(ce.getAttribute(o,"/ce/rule/Built"))
        if attrvalue!=None:
            BuiltYear=int(attrvalue)
            if BuiltYear>YearBuilt:
                selection.append(o)
   ce.setSelection(selection)
if __name__ == '__main__':
  SelectBuildingsByYear(1990)
```

Appendix C – Generate new scenario Python Script

```
#Change the selected buildings into green parking lots
def BuildingToParkinglot():
    objects=ce.getObjectsFrom(ce.selection())
    for o in objects:
        ce.setRuleFile(o,"rules/ParkingLot.cga")
        ce.setStartRule(o,"Lot")
        MakeModels()
#Change the selected parking lots into buildings
def ParkinglotToBuilding():
    objects=ce.getObjectsFrom(ce.selection())
    for o in objects:
        ce.setRuleFile(o,"rules/Buildings/Building.cga")
        ce.setStartRule(o,"Buildings")
        MakeModels()
#Adjust the selected street width and sidewalk width
def AdjustStreetWidth(StreetWidth):
    selectedSegments = ce.getObjectsFrom(ce.selection())
    for segment in selectedSegments:
        ce.setAttribute(segment, "/ce/street/streetWidth", StreetWidth)
        ce.generateModels(segment)
def AdjustStreetSideWalk(increment):
    selectedSegments = ce.getObjectsFrom(ce.selection, ce.isGraphSegment)
    for segment in selectedSegments:
        Left=float(ce.getAttribute(segment, "sidewalkWidthLeft"))
        Left=Left+increment
        Right=float(ce.getAttribute(segment, "sidewalkWidthRight"))
        Right=Right+increment
```

```
ce.setAttribute(segment, "/ce/street/sidewalkWidthLeft", Left)
ce.setAttribute(segment, "/ce/street/sidewalkWidthRight", Right)
```

Appendix D – Export statistics table for selected features Python Script

```
#Export the attributes for the selected objects to a txt file

# Globals

gInstanceData = "" # global string that collects all data to be written

gInstanceCount = 0 # global count to enumerate all instances

# Called for each initial shape after generation.

def finishModel(exportContextOID, initialShapeOID, modelOID):

    global gInstanceData, gInstanceCount

    model = Model(modelOID)

    if(model.getReports().has_key('asset')): # only write t3d entry if report data available

        # there might be more than one asset per model, therefore loop

        l = len(model.getReports()['asset'])

        for i in range(0,l):

            instanceData = processInstance(model.getReports(),gInstanceCount, i-1)

            gInstanceData = gInstanceData+instanceData

            gInstanceCount = gInstanceCount+1

def processInstance(reports, count, index):

    ## remove path from asset string

    asset = reports['asset'][index]

    asset = asset.rpartition("/")[2]

    ## prepare the string for the instance map

    text  = "%d\t" % count;

    text += "%s\t" % asset;

    text += "%.3f\t%.3f\t%.3f\t" % (reports['xpos'][index],reports['ypos'][index],
reports['zpos'][index])

    text += "%.3f\t%.3f\t%.3f\t" % (reports['xrot'][index],reports['yrot'][index],
reports['zrot'][index])

    text += "%.3f\t%.3f\t%.3f\n" % (reports['xscale'][index], reports['yscale'][index],
reports['zscale'][index])
```

```
    return text
# Called after all initial shapes are generated.
def finishExport(exportContextOID):
    global gInstanceData, gInstanceCount
    ## path of the output file
    file = ce.toFSPath("maps")+"/instanceMap.txt"
    ## write collected data to file
    writeFile(file, gInstanceData)
    print str(gInstanceCount)+"instances written to "+file +"\n"
```

Appendix E – Reset the scene in Android mobile game C# Script

```
using System.Collections;
using System.Collections.Generic;
using UnityEngine;
using UnityEngine.SceneManagement;

public class Reset : MonoBehaviour {

	public void ResetScene(string name)
	{
		SceneManager.LoadScene (SceneManager.GetActiveScene ().name);
	}
}
```

Appendix F – Imperviousness percentage change by parcel

I_PCT_C: Impervious percentage by parcel in the current scenario.

I_PCT_P: Impervious percentage by parcel in the predicted green scenario.

I_PCT_D: Differences of the impervious percentage by parcel between current and predicted scenarios.

ObjectID	Parcel	I_PCT_C	I_PCT_P	I_PCT_D
1	NA	92.95%	87.72%	5.23%
2	RPCPP111007	100.00%	75.91%	24.09%
3		100.00%	74.79%	25.21%
4	RPMSH000600	91.07%	1.00%	90.07%
5		91.03%	1.00%	90.03%
6		91.04%	1.00%	90.04%
7	RPPOC261400	100.00%	98.23%	1.77%
8	RPCPP129700	86.21%	50.04%	36.16%
9	RPIDA001100	99.74%	87.94%	11.80%
10	NA	100.00%	99.82%	0.18%
11	RPCPP046202	97.58%	19.67%	77.91%
12	RPCPP046205	75.95%	62.95%	13.00%
13		89.07%	84.19%	4.88%
14	RPBMT000100	77.43%	61.18%	16.25%
15	RCPRM000202	99.89%	50.28%	49.61%
16	RPCPP002205	80.63%	41.07%	39.57%
17	NA	100.00%	98.80%	1.20%
18	RCCPC029102	75.67%	55.59%	20.08%
19	NA	99.97%	99.90%	0.08%
20	RCBBA005100	89.00%	29.01%	59.99%
21	RPBMT000100	92.29%	30.24%	62.05%
22	RPBMT001300	79.22%	74.66%	4.56%
23	RPPSQ001600	84.15%	42.39%	41.76%
24	RPBMT001300	86.42%	36.43%	49.99%
25	RPPSQ000100	89.05%	38.50%	50.55%
26		99.99%	99.82%	0.17%
27	RCWIL000700	81.97%	32.03%	49.94%
28	RPBMT001206	92.82%	47.75%	45.07%
29	RPBMT001204	91.43%	44.17%	47.27%
30	RPIDA000300	95.91%	90.50%	5.41%
31	RPCPP078004	86.68%	76.88%	9.79%
32	RPCPP047600	97.05%	3.11%	93.94%
33	RPCPP049502	99.76%	67.94%	31.82%
34	RPPMT008402	98.66%	33.93%	64.74%
35	RPBNV004700	94.29%	41.66%	52.63%

36	RPCPP052500	100.00%	86.23%	13.77%
37	NA	99.91%	99.90%	0.01%
38	RPCPP068100	85.36%	21.89%	63.47%
39	RPIDL001500	91.79%	54.00%	37.78%
40	RPIDT002102	86.73%	53.07%	33.66%
41	RPIDL002400	97.20%	20.96%	76.24%
42	RPCPP071504	92.74%	12.53%	80.22%
43	NA	99.99%	99.15%	0.84%
44	RPGET001100	94.37%	66.81%	27.56%
45	NA	99.92%	96.76%	3.16%
46	NA	73.20%	0.18%	73.02%
47	RPBNV006801	86.53%	26.77%	59.76%
48	RPBNV005000	99.61%	53.38%	46.24%
49	RPBNV004900	99.85%	33.53%	66.33%
50	RPCPP052400	100.00%	82.28%	17.72%
51	RPCPP069900	88.24%	54.08%	34.16%
52	RPCPP067000	96.74%	37.90%	58.84%
53	RPCPP068100	81.29%	34.59%	46.70%
54	RPCPP052300	100.00%	58.67%	41.33%
55	RPLVH001400	82.47%	43.20%	39.28%
56	NA	99.90%	99.27%	0.63%
57	RPCPP068100	87.99%	68.67%	19.32%
58	RPIDT000900	99.57%	3.12%	96.45%
59	RPCPP068100	92.34%	10.94%	81.40%
60	RPMNT000900	100.00%	1.25%	98.75%
61	RPIDT001100	98.91%	97.59%	1.31%
62	NA	99.95%	95.53%	4.42%
63	RPIDT002200	99.60%	37.00%	62.60%
64	RPCPP068100	90.95%	16.36%	74.58%
65	RPCPP068100	92.19%	28.00%	64.19%
66	RPCPP063601	100.00%	98.98%	1.02%
67	RPCPP063601	97.46%	73.92%	23.54%
68	RPCPP063512	99.78%	45.36%	54.42%
69	RPCPP063510	97.58%	40.01%	57.57%
70	NA	99.91%	99.50%	0.41%
71	RPCPP067000	100.00%	99.48%	0.52%
72	RPCPP071502	99.91%	87.28%	12.63%
73	RPCPP068100	98.34%	29.34%	69.01%
74	NA	100.00%	99.76%	0.24%
75	RPCPP080300	77.94%	52.27%	25.67%
76	RPIDT002000	97.02%	48.65%	48.38%

77	RPCPP049800	91.86%	54.27%	37.59%
78	RPPFV020800	99.90%	71.88%	28.01%
79	RPIDL000700	80.51%	57.51%	23.00%
80	RPIDL000801	99.99%	49.66%	50.33%
81	RPCPP077802	75.97%	65.04%	10.93%
82	RPCPP076300	90.59%	89.56%	1.02%
83	RPFMS000400	86.36%	36.62%	49.74%
84	RPCPP049800	88.22%	64.87%	23.36%
85	RPCPP049700	89.76%	43.21%	46.54%
86	RPIDL000802	100.00%	42.01%	57.99%
87	RPIDL001300	84.12%	80.63%	3.49%
88	RPCPP049600	100.00%	75.17%	24.83%
89	RPFMS000800	91.64%	47.94%	43.70%
90	RPADL001000	90.05%	53.12%	36.93%
91		100.00%	100.00%	0.00%
92	RPIDA001100	99.40%	82.55%	16.85%
93	RPIDA001001	97.31%	49.07%	48.24%
94	RPIDA001001	95.24%	93.98%	1.26%
95	RPIDA001001	100.00%	6.00%	94.00%
96	RPIDA001100	99.47%	77.89%	21.59%
97	RPCPP075900	89.24%	88.02%	1.22%
98	RPCPP047500	100.00%	26.31%	73.69%
99	RPCPP047401	91.79%	9.08%	82.71%
100	RPIDA002601	93.71%	73.14%	20.58%
101	RPCPP076200	92.74%	87.69%	5.05%
102	RPCPP075900	99.28%	11.77%	87.51%
103	RPNPB000102	99.68%	62.83%	36.85%
104	RPCPP075900	92.61%	87.32%	5.28%
105	RPNPB000802	99.84%	30.90%	68.94%
106	RPNPB000901	100.00%	72.28%	27.72%
107	RPCPP047300	94.13%	35.84%	58.30%
108	RPIDA000801	99.39%	42.53%	56.86%
109	RPIDA001100	99.83%	93.19%	6.64%
110	RPNPB000502	99.05%	23.42%	75.63%
111	RPNPB000601	100.00%	72.03%	27.97%
112	RPNPB000502	99.52%	45.64%	53.88%
113	RPNPB000501	100.00%	72.33%	27.67%
114	RPCPP076000	71.68%	69.11%	2.57%
115	RPCPP077303	69.90%	0.73%	69.17%
116	RPIDA001001	95.12%	68.15%	26.97%
117	RPNPB000400	99.86%	67.28%	32.58%

118	RPFMS000500	78.96%	54.93%	24.03%
119	RPFMS000900	99.11%	45.29%	53.81%
120	RPNPB001002	99.92%	42.56%	57.36%
121	RPCPP047600	94.62%	8.84%	85.78%
122	RPFMS000700	85.25%	63.58%	21.67%
123	RPTAS000401	97.50%	47.23%	50.27%
124	RPCVT003600	94.50%	72.13%	22.38%
125	NA	100.00%	98.91%	1.09%
126	RPNPB000702	99.52%	25.91%	73.62%
127	RPNPB000701	100.00%	72.21%	27.79%
128	RPNPB001001	100.00%	72.51%	27.49%
129	RPNPB001600	99.98%	20.82%	79.16%
130	RPCPP047200	98.98%	34.29%	64.70%
131	RPNPB001400	100.00%	46.22%	53.78%
132	RPNPB001200	100.00%	91.22%	8.78%
133	RPIDA003801	99.97%	85.77%	14.20%
134	NA	28.69%	0.41%	28.28%
135	RPCRA000300	67.74%	55.00%	12.75%
136	RPTAS001101	100.00%	55.22%	44.78%
137	RPTAS000801	99.60%	26.54%	73.06%
138	RPNPB001700	100.00%	8.49%	91.51%
139	RPNPB001500	100.00%	47.47%	52.53%
140	RPFMS000300	90.04%	32.50%	57.54%
141	RPCPP047200	100.00%	13.96%	86.04%
142	RPCPP064600	100.00%	94.86%	5.14%
144	RPIDA000300	100.00%	41.59%	58.41%
145	NA	100.00%	99.80%	0.20%
146	NA	99.95%	99.60%	0.35%
147	RPGNA000100	83.65%	38.76%	44.88%
148	RPGNA000200	99.05%	95.76%	3.29%
149	RPCPP039708	94.74%	27.19%	67.54%
150	RPADL001000	98.60%	4.43%	94.17%
151	RPCVT004200	100.00%	60.22%	39.78%
152	RPCVT004201	100.00%	30.83%	69.17%
153	RPGNA001900	94.05%	28.98%	65.07%
154	RPTAS000203	71.83%	37.97%	33.86%
155	RPIDA003800	90.52%	40.80%	49.72%
156	RPOLT000300	99.90%	68.45%	31.45%
157	RPIDA003802	95.16%	36.74%	58.41%
158	RPFMS000100	83.19%	51.50%	31.69%
159	RPNXT001300	88.91%	29.00%	59.91%

160	RPGN1000300	92.14%	54.53%	37.61%
161	RPCPP039702	87.00%	37.69%	49.31%
162	RPCPP019601	96.85%	13.84%	83.01%
163	RPGNA001800	99.97%	96.28%	3.69%
164	RPGN1000100	95.72%	54.92%	40.80%
165	RPYHA000501	99.95%	93.43%	6.52%
166	RPCPP011804	76.61%	63.62%	12.99%
167	RPCVT004300	100.00%	44.25%	55.75%
168	RPCVT004301	100.00%	18.90%	81.10%
169	RPTAS000501	99.04%	47.50%	51.53%
170	RPGNA000302	100.00%	46.09%	53.91%
171	RPGNA000303	92.62%	40.06%	52.56%
172	RPTAS000701	91.34%	33.77%	57.57%
173		75.46%	68.82%	6.63%
174	RPCPP044846	100.00%	63.85%	36.15%
175	RPTAS000601	97.90%	46.75%	51.15%
176	RPSHP000100	78.81%	58.34%	20.47%
177	NA	99.64%	78.94%	20.70%
178	RPCPP022300	99.93%	26.32%	73.61%
179	RPCPP012800	91.09%	48.42%	42.68%
180	RPCPP022000	77.64%	74.93%	2.70%
181	RPSV1001501	98.60%	94.29%	4.30%
182	RPSHP000200	77.49%	63.25%	14.24%
183	RPPOP000600	64.94%	57.91%	7.03%
184		92.53%	36.64%	55.90%
185	RPCPP033500	72.65%	55.13%	17.52%
186	RPPOP000100	75.18%	55.93%	19.25%
187	RPCPP022100	99.84%	46.87%	52.97%
188	RPHA2000900	100.00%	100.00%	0.00%
189	RPPOP000303	88.75%	43.74%	45.00%
190	RPGNA001400	87.90%	47.33%	40.57%
191	RPGN1000201	91.72%	42.07%	49.65%
192	RPYHA001700	71.50%	63.87%	7.63%
193	RPYHA001600	100.00%	99.01%	0.99%
194	RPPOP000400	70.90%	68.67%	2.24%
195	RPPOP000200	89.23%	52.86%	36.36%
196	RPTAS004400	64.03%	41.29%	22.73%
197	RPYHA001100	90.68%	59.06%	31.61%
198	RPYHA002201	90.20%	70.26%	19.94%
199	RPYHA001000	99.82%	94.54%	5.28%
200	RPTAS004600	92.15%	34.38%	57.77%

201	RPTAS005600	99.71%	99.06%	0.65%
202	RPYHA000801	97.64%	63.69%	33.95%
203	RPYHA000800	90.98%	57.64%	33.34%
204	RPYHA001000	99.83%	92.93%	6.90%
205	RPYHA000900	97.00%	36.20%	60.81%
206	RPYHA001000	100.00%	98.39%	1.61%
207	RPKHM000100	86.99%	35.69%	51.29%
208	RPKHM000300	94.90%	63.68%	31.22%
209	RPCPP007600	88.66%	42.54%	46.12%
210	RPCPP011805	85.84%	56.91%	28.93%
211	RPKHM000200	84.67%	71.51%	13.16%
212	RPKHM000400	77.00%	75.76%	1.24%
213	RPTAS005700	82.41%	55.91%	26.50%
214	RPTAS005402	92.13%	35.13%	57.00%
215	RPTAS005401	87.16%	64.01%	23.16%
216	RPTAS005600	100.00%	90.11%	9.89%
217	NA	99.78%	99.47%	0.31%
218	RPCPP011805	96.65%	29.33%	67.31%
219	RPPLT003000	83.77%	77.42%	6.36%
220	RPCPP011805	97.44%	54.21%	43.23%
221	RPYHA000100	80.18%	50.85%	29.33%
222	RPHOM000100	56.66%	26.29%	30.36%
223	RPYHA000101	100.00%	52.53%	47.47%
224	RPTAS005801	91.47%	49.23%	42.24%
225	RPCPP029100	100.00%	98.96%	1.04%
226	RPCPP012701	71.49%	43.80%	27.69%
227	RPCPP017500	99.96%	98.86%	1.10%
228	RPGRF002701	94.70%	29.63%	65.07%
229	RPGRF001000	74.69%	38.94%	35.75%
230	RPEA2000302	62.53%	56.96%	5.58%
231	RPTAS004701	87.27%	82.00%	5.27%
232	RPYHA001101	90.60%	61.78%	28.82%
233	RPYHA001000	99.83%	99.42%	0.41%
234	RPTAS003601	91.58%	49.58%	42.00%
235	RPGRF001400	96.76%	36.69%	60.07%
236	RPGRF001700	99.22%	70.10%	29.12%
237	RPGRF001400	99.44%	28.78%	70.66%
238	RPHO1004200	90.72%	41.02%	49.70%
239	RPHO1005200	92.07%	46.47%	45.60%
240	RPGRF001301	95.87%	26.44%	69.43%
241	RPGRF000900	79.31%	60.26%	19.05%

242	RPFW2001800	70.86%	49.28%	21.58%
243	RPFRG003702	100.00%	9.53%	90.47%
244	RPFRG003702	99.89%	76.14%	23.76%
245	RPCPP005300	57.91%	55.54%	2.37%
246	RPGRF001200	84.72%	30.18%	54.54%
247	RPGRF000800	67.10%	49.08%	18.02%
248	NA	100.00%	95.77%	4.23%
249	RPCPP015305	82.32%	43.74%	38.59%
250	RPFRG003702	99.92%	18.21%	81.70%
251	RPFRG003701	94.68%	70.82%	23.87%
252	RPTAS004800	81.88%	46.07%	35.81%
253	RPCPP015303	86.79%	31.57%	55.21%
254	RPILP000200	97.01%	27.98%	69.02%
255	RPCPP017500	97.22%	96.71%	0.51%
256	RPCPP015606	94.05%	26.56%	67.49%
257	RPCPP015501	81.78%	53.96%	27.82%
258	RPCPP027400	28.13%	0.37%	27.76%
259	RPMCS000100	83.13%	59.70%	23.43%
260	RPCPP001900	99.79%	93.82%	5.97%
261	RCPRM000100	85.40%	38.77%	46.63%
262	RCCPC028801	91.86%	32.19%	59.67%
263	RCCPC028802	100.00%	97.74%	2.26%
264	RPCPP015502	93.71%	19.37%	74.35%
265	NA	100.00%	97.02%	2.98%
266	RCPRT002202	65.92%	58.59%	7.32%
267	RPCPP013500	98.47%	6.17%	92.30%
268	RCCPC030301	93.53%	49.48%	44.06%
269	NA	92.53%	9.03%	83.50%
270	RPING007700	74.90%	54.59%	20.31%
271	RPCPP004605	73.65%	55.41%	18.24%
272	RCCPC031600	84.51%	24.92%	59.60%
273	RCCPC030400	59.83%	45.41%	14.43%
274	RCCPC030302	99.01%	56.00%	43.01%
275	RCCPC030100	89.30%	30.58%	58.73%
276	RCCPC030000	54.53%	45.81%	8.71%
277	RCIGP000303	87.62%	13.94%	73.68%
278	RCCPC029800	78.77%	35.83%	42.94%
279	RCKC1001300	78.16%	44.62%	33.54%
280	R3853016400	81.92%	74.77%	7.15%
281	RCIGP000201	81.20%	20.64%	60.56%
282	RCIGP000302	81.22%	52.46%	28.76%

283	RCIGP000304	63.92%	36.71%	27.21%
284	RPGRH000100	67.92%	59.23%	8.68%
285	RCKC1000100	79.39%	57.70%	21.69%
286	RCCPC031600	78.76%	32.43%	46.32%
287	RCCPC026000	89.92%	51.94%	37.98%
288	RCRAK000300	91.03%	38.83%	52.20%
289	NA	100.00%	95.84%	4.16%
290	RCBRR008800	100.00%	99.98%	0.02%
291	NA	99.95%	99.08%	0.87%
292	NA	99.82%	94.07%	5.75%
293	RCBBA005000	82.78%	40.56%	42.23%
294		10.31%	0.29%	10.02%
295	93009201	98.69%	43.34%	55.35%
296	RCBBA002100	75.45%	58.75%	16.70%
297	RPING007800	81.52%	28.88%	52.65%
298	RCCPC036104	97.42%	76.15%	21.26%
299	RCBBA003700	64.06%	61.98%	2.08%
300	RCCPC035202	96.91%	37.48%	59.43%
301	RCHIH004701	37.39%	0.09%	37.29%
302	RCBBA002200	86.01%	79.54%	6.47%
303	RCBBA001700	88.95%	35.07%	53.88%
304	RCBBA002200	75.27%	65.38%	9.89%
305	RCBBA001603	99.56%	1.93%	97.63%
306	RCBBA000400	79.21%	76.48%	2.73%
307	RCBBA002000	95.32%	41.44%	53.88%
308	RCRAK000101	88.45%	45.33%	43.13%
309	RCBBA000901	68.25%	35.72%	32.53%
310	RCBBA001101	68.82%	61.70%	7.12%
311	RCBBA000701	92.04%	22.44%	69.60%
312	RCBBA000310	97.07%	44.02%	53.05%
313	RCBBA000308	86.81%	49.85%	36.95%
314	RCHIH004500	39.39%	0.53%	38.86%
315	RCPRT002203	78.89%	39.93%	38.95%
316	RCPRT002300	76.58%	22.39%	54.19%
317	RCBRT000102	91.97%	48.49%	43.49%
318	NA	99.63%	99.16%	0.47%
319	RCBRT000101	93.15%	49.28%	43.88%
320	NA	72.98%	0.72%	72.27%
321	RPCPP073901	92.27%	52.28%	40.00%
322	RPCPP052203	99.96%	97.71%	2.26%
323	RPCPP052203	94.60%	51.00%	43.60%

324	RPBNV007300	97.99%	55.62%	42.37%
325	RPCPP073700	99.97%	70.90%	29.07%
326	RPBNV007000	99.17%	7.71%	91.46%
327	RPBNV007200	99.55%	47.46%	52.10%
328	RPVIC004300	99.17%	11.73%	87.44%
329	RPCPP073600	99.26%	41.21%	58.05%
330	RPGWD001600	100.00%	40.87%	59.13%
331	RPCPP070100	100.00%	99.82%	0.18%
332	RP18A001002	100.00%	99.48%	0.52%
333	RPGWD000102	100.00%	18.09%	81.91%
334	RPGWD000101	100.00%	55.11%	44.89%
335	RPNPT000800	100.00%	42.97%	57.03%
336	RPGVC003202	99.50%	63.11%	36.39%
337	RPGVC002100	96.69%	52.92%	43.77%
338	RPGWD000200	99.94%	63.04%	36.90%
339	NA	98.19%	97.42%	0.77%
340	RPCPP053601	54.26%	47.44%	6.83%
341	RPCPP063509	97.46%	44.19%	53.27%
342	RPNPT000900	99.83%	71.44%	28.39%
343	RPPOC221102	100.00%	99.89%	0.11%
344	RPCPP063511	98.26%	32.33%	65.93%
345	RPCPP052901	99.97%	6.01%	93.96%
346	RPCPP053601	86.14%	85.46%	0.69%
347	RPGVC002500	87.95%	49.34%	38.61%
348	RPFRV006900	98.90%	57.15%	41.74%
349	NA	79.73%	78.82%	0.92%
350	RPCPP090700	99.50%	99.49%	0.00%
351	RPCPP053001	99.99%	96.51%	3.48%
352	RPGVC002900	99.20%	87.21%	11.98%
353	RPNPT000300	98.04%	29.76%	68.28%
354	RPGVC002800	99.22%	41.40%	57.82%
355	RPCPP090300	94.82%	67.48%	27.34%
356	RPCPP063512	100.00%	40.02%	59.98%
357	RPCPP063506	99.95%	0.42%	99.53%
358	RPGVC002400	99.22%	4.68%	94.54%
359	RPTHD000601	66.65%	53.36%	13.29%
360	RPTHD000300	76.70%	58.56%	18.14%
361	RPNPT015300	81.72%	69.63%	12.09%
362	RPGVC003400	99.83%	99.26%	0.58%
363	RPFRV006500	99.08%	55.40%	43.68%
364	RPFRV006600	98.91%	53.14%	45.76%

365	RPFRV006700	98.89%	52.11%	46.78%
366	RPFRV006800	98.83%	51.42%	47.40%
367	RPTHD000700	78.08%	65.68%	12.39%
368	RPFRV007000	98.89%	66.89%	32.00%
369	RPFRV007100	98.88%	48.99%	49.89%
370	RPCPP083102	92.28%	71.30%	20.99%
371		52.86%	0.00%	52.86%
372	RPCPP063307	85.83%	18.60%	67.23%
373	RPMRT002600	99.96%	44.16%	55.80%
374	RPCPP063304	98.85%	46.31%	52.54%
375	RPNPT015400	100.00%	4.08%	95.92%
376	RPPOC220801	99.95%	75.81%	24.14%
377	NA	89.11%	88.05%	1.06%
378	RPFRV007500	99.12%	6.93%	92.20%
379	RPMRT002500	99.12%	1.72%	97.40%
380	NA	94.94%	0.62%	94.32%
381		70.65%	55.79%	14.86%
382	NA	97.61%	75.43%	22.18%
383	RPCPP089700	100.00%	93.10%	6.90%
384	RPCPP090500	96.58%	92.16%	4.42%
385	NA	56.31%	18.03%	38.28%
386	RPPOC036401	99.83%	46.13%	53.71%
387	RPPOC036402	94.23%	7.86%	86.37%
388	RPPOC002700	73.00%	59.12%	13.88%
389	RPPOC151500	85.73%	60.23%	25.50%
390	RPPOC002900	79.23%	55.98%	23.24%
391	RR	93.88%	29.27%	64.60%
392	RPCPP090202	99.61%	99.56%	0.05%
393	RPPOC007500	87.99%	34.85%	53.14%
394	NA	76.78%	63.94%	12.85%
395	RPPOC013101	81.38%	52.34%	29.04%
396	RPPOC309100	96.18%	96.17%	0.01%
397	NA	100.00%	100.00%	0.00%
398	RPPOC259700	84.45%	63.88%	20.57%
399	RPPOC255404	99.77%	99.58%	0.18%
400	NA	94.43%	76.55%	17.88%
401	RPPOC152600	100.00%	88.52%	11.48%
402		99.17%	26.49%	72.69%
403	RPPOC153000	99.39%	3.47%	95.92%
404	NA	88.46%	63.04%	25.41%
405	RPPOC150200	77.82%	66.41%	11.41%

406	NA	99.60%	66.26%	33.34%
407	NA	95.97%	87.50%	8.47%
408	NA	91.09%	68.84%	22.25%
409	NA	98.26%	48.66%	49.60%
410	NA	91.09%	86.57%	4.52%
411	NA	87.06%	75.84%	11.22%
412	RPPOC180500	100.00%	62.12%	37.88%
413	RPPOC156000	99.57%	2.93%	96.64%
414	NA	99.93%	69.64%	30.29%
415	NA	82.17%	62.22%	19.94%
416	RPPOC153100	96.73%	68.70%	28.03%
417	NA	85.08%	72.68%	12.41%
418	RPPOC267500	99.64%	28.97%	70.67%
419	RPPOC182800	99.95%	11.37%	88.58%
420	NA	96.68%	74.85%	21.83%
421	RPPOC178800	80.35%	22.02%	58.34%
422	NA	97.52%	86.12%	11.39%
423	RPPOC259700	99.98%	41.18%	58.80%
424	NA	99.90%	63.89%	36.01%
425	RPGAR001100	52.42%	51.07%	1.35%
426	RPPOC304900	79.98%	42.76%	37.22%
427	NA	95.32%	73.41%	21.91%
428	NA	92.79%	70.34%	22.45%
429	RPPOC022900	96.49%	14.08%	82.42%
430	RPPOC262602	99.98%	2.24%	97.73%
431	RPPOC178400	100.00%	27.92%	72.08%
432	NA	98.04%	74.91%	23.12%
433	RPPOC027500	83.32%	59.34%	23.98%
434	RPPOC149700	99.94%	4.21%	95.73%
435	RPPOC306000	99.24%	93.77%	5.47%
436	NA	88.01%	85.06%	2.95%
437	NA	88.19%	84.06%	4.13%
438	RPPOC149600	96.10%	5.40%	90.70%
439	NA	93.40%	82.77%	10.62%
440	NA	96.99%	79.62%	17.37%
441	RPPOC178700	98.37%	87.33%	11.05%
442	RPUPC000800	97.22%	55.09%	42.14%
443	RPPOC028100	88.12%	54.61%	33.51%
444	NA	86.48%	82.12%	4.36%
445	NA	86.99%	84.46%	2.53%
446	NA	97.79%	70.26%	27.53%

447	NA	95.33%	83.74%	11.60%
448	RPPOC312600	99.83%	97.76%	2.07%
449	NA	97.91%	74.95%	22.96%
450	RPPOC262700	95.96%	67.72%	28.25%
451	NA	99.83%	66.26%	33.58%
452	RPPOC303800	77.98%	29.78%	48.20%
453	NA	97.44%	70.38%	27.06%
454	RPPOC262601	87.56%	49.08%	38.49%
455	RPPOC154800	100.00%	1.92%	98.08%
456	RPPOC180400	100.00%	1.03%	98.97%
457	RPPOC154900	99.84%	7.89%	91.95%
458	RPPOC180600	100.00%	27.95%	72.05%
459	RPPOC180900	100.00%	44.44%	55.56%
460	NA	73.84%	54.84%	18.99%
461	NA	98.08%	73.41%	24.67%
462	NA	93.32%	84.51%	8.81%
463	NA	97.56%	63.03%	34.54%
464	RPPOC266100	84.60%	41.17%	43.44%
465	NA	95.10%	74.85%	20.25%
466	RPPOC181100	84.24%	78.77%	5.47%
467	RPPOC181200	99.95%	3.93%	96.02%
468	RPPOC181305	99.85%	81.92%	17.93%
469	NA	95.59%	70.38%	25.22%
470	RPCT1001900	37.31%	0.42%	36.89%
471	NA	95.61%	81.75%	13.86%
472	RPPOC266000	92.18%	58.08%	34.10%
473	NA	89.57%	78.04%	11.53%
474	RPPOC145500	95.91%	48.20%	47.70%
475	RPPOC219500	93.08%	39.02%	54.06%
476	NA	91.88%	71.12%	20.76%
477	NA	100.00%	99.79%	0.21%
478	NA	77.16%	75.43%	1.72%
479	RPPOC186300	99.90%	98.04%	1.86%
480	NA	95.41%	74.05%	21.36%
481	NA	94.80%	72.76%	22.03%
482	RPPOC265900	99.89%	44.86%	55.03%
483	NA	96.62%	87.61%	9.02%
484	RPPOC182000	91.98%	48.04%	43.94%
485	RPCT1001600	30.05%	0.48%	29.58%
486	RPPOC182600	90.50%	24.47%	66.03%
487	RPPOC267602	99.80%	41.46%	58.34%

488	RPPOC158700	94.12%	53.96%	40.15%
489	NA	95.00%	76.21%	18.79%
490	RPPOC183800	94.00%	19.86%	74.14%
491	NA	94.09%	76.82%	17.26%
492	RPPOC175900	97.66%	33.52%	64.15%
493	NA	95.23%	70.61%	24.62%
494	NA	96.39%	92.74%	3.64%
495	NA	95.46%	72.41%	23.05%
496	NA	96.24%	73.86%	22.38%
497	RUPOC183600	93.58%	74.68%	18.90%
498	RPPOC184300	99.83%	18.77%	81.06%
499	NA	86.06%	67.78%	18.27%
500	RPPOC219800	100.00%	6.30%	93.70%
501	RPPOC267400	99.38%	28.02%	71.35%
502	NA	95.86%	68.94%	26.92%
503	RUPOC218800	76.93%	29.59%	47.34%
504	RUPOC183700	89.38%	47.37%	42.00%
505	RPPOC159700	95.41%	29.43%	65.98%
506	RPPOC267601	99.65%	22.05%	77.60%
507	NA	84.53%	75.72%	8.81%
508	NA	95.44%	81.57%	13.87%
509	NA	97.61%	92.06%	5.55%
510	RPPOC219300	86.38%	28.44%	57.94%
511	RPPOC158100	93.96%	45.63%	48.32%
512	NA	95.54%	77.94%	17.60%
513	RPCPP111005	3.17%	0.02%	3.14%
514	RPPOC183300	96.35%	15.15%	81.20%
515	NA	95.80%	75.13%	20.68%
516	NA	97.19%	73.82%	23.38%
517		96.33%	68.87%	27.47%
518	RPPOC299400	91.74%	46.36%	45.38%
519	NA	95.38%	69.38%	26.00%
520	NA	97.78%	93.66%	4.12%
521	NA	97.05%	75.10%	21.96%
522	RPPOC216700	99.54%	27.48%	72.07%
523	RPPOC188400	98.72%	59.98%	38.74%
524	RUPOC183400	81.20%	23.65%	57.55%
525	RUPOC183500	92.83%	29.07%	63.76%
526	RUPOC218700	78.79%	26.88%	51.92%
527	NA	97.90%	71.73%	26.18%
528	RPPOC219000	96.82%	95.36%	1.46%

529	RPWPO004700	100.00%	75.11%	24.89%
530	RPPOC159000	99.65%	38.49%	61.16%
531		94.59%	70.82%	23.77%
532	RUPOC218900	97.37%	6.44%	90.93%
533	RUPOC217000	74.95%	69.76%	5.19%
534	NA	92.72%	70.57%	22.16%
535	RPPOC173300	92.74%	28.18%	64.56%
536	RPPOC173700	80.13%	66.13%	14.01%
537	NA	91.83%	86.67%	5.16%
538	NA	97.44%	75.55%	21.88%
539	NA	97.47%	73.59%	23.88%
540	NA	93.67%	68.63%	25.04%
541	NA	99.60%	72.54%	27.06%
542	RPPOC216801	99.61%	48.24%	51.37%
543	RPPOC173500	99.46%	46.68%	52.78%
544	NA	97.76%	90.41%	7.34%
545	NA	99.72%	79.53%	20.19%
546	RPPOC297200	99.48%	91.64%	7.84%
547	NA	96.60%	71.26%	25.34%
548	NA	98.31%	68.85%	29.45%
549	NA	97.43%	70.49%	26.94%
550	RPPOC216600	93.85%	18.56%	75.29%
551	NA	97.77%	80.94%	16.83%
552	NA	96.42%	81.85%	14.57%
553	RPPOC173100	79.44%	27.62%	51.83%
554	RPCPP086600	99.96%	99.59%	0.37%
555	RPCT2002100	74.94%	37.30%	37.64%
556	RPPOC185800	84.14%	38.07%	46.07%
557	RPPOC172900	92.09%	60.71%	31.38%
558	NA	92.85%	73.06%	19.79%
559	NA	92.87%	73.11%	19.76%
560	NA	99.80%	72.35%	27.44%
561	NA	83.32%	79.87%	3.45%
562	NA	96.74%	75.38%	21.36%
563	NA	94.15%	71.15%	23.00%
564	RPPOC173200	83.59%	26.04%	57.54%
565	NA	96.63%	79.53%	17.10%
566	RPPOC275800	99.75%	99.67%	0.09%
567	NA	99.97%	95.11%	4.85%
568	NA	88.06%	74.23%	13.84%
569	RPPOC173000	93.13%	45.84%	47.29%

570	RPPOC243900	99.41%	5.44%	93.97%
571	NA	85.34%	72.00%	13.34%
572	RPPOC135300	96.27%	17.73%	78.54%
573	NA	97.76%	72.84%	24.92%
574	NA	99.89%	98.89%	1.00%
575	RPPOC172400	96.33%	10.18%	86.15%
576	RPPOC224300	97.39%	45.25%	52.14%
577	NA	96.86%	80.23%	16.62%
578	RPPOC186100	100.00%	100.00%	0.00%
579	RPPOC215100	75.57%	62.59%	12.98%
580		100.00%	71.30%	28.70%
581	NA	99.90%	72.27%	27.63%
582	NA	83.58%	81.29%	2.29%
583	RPPOC215500	97.28%	41.35%	55.93%
584	NA	95.64%	72.97%	22.67%
585	NA	91.02%	62.42%	28.59%
586	NA	88.35%	67.85%	20.51%
587	NA	94.15%	59.63%	34.52%
588	NA	96.64%	73.53%	23.11%
589	NA	94.92%	77.34%	17.58%
590	RPPOC089800	79.47%	73.48%	5.99%
591	RPPOC295000	99.56%	55.83%	43.73%
592	RPPOC243900	96.41%	34.31%	62.10%
593	NA	96.46%	95.49%	0.97%
594	NA	93.72%	86.95%	6.77%
595	RPPOC295200	97.53%	96.99%	0.54%
596	NA	97.87%	95.09%	2.78%
597	NA	98.55%	72.41%	26.14%
598		94.17%	37.52%	56.65%
599	NA	97.47%	95.84%	1.63%
600	NA	96.79%	77.92%	18.87%
601	RPPOC325300	97.58%	55.11%	42.47%
602	RPPOC243800	99.23%	67.76%	31.47%
603	RPPOC186500	92.50%	63.29%	29.22%
604	RPPOC214300	99.51%	5.32%	94.19%
605	NA	94.93%	81.81%	13.12%
606	NA	96.72%	69.15%	27.57%
607	NA	88.46%	68.92%	19.54%
608	RPPOC225601	99.08%	69.37%	29.71%
609	NA	97.49%	75.05%	22.45%
610	NA	98.37%	83.05%	15.31%

611	RPPOC214900	96.49%	34.51%	61.98%
612	RPPOC225501	94.56%	7.94%	86.62%
613	NA	96.28%	65.14%	31.14%
614	RPPOC214800	96.97%	5.82%	91.15%
615	RPPOC225500	86.16%	22.88%	63.28%
616	RPPOC135200	94.10%	92.36%	1.74%
617	NA	91.46%	89.70%	1.76%
618	RPPOC294900	91.61%	23.47%	68.15%
619	NA	98.48%	76.52%	21.96%
620	RPPOC294500	99.83%	99.75%	0.08%
621	RR	88.84%	84.35%	4.49%
622	RPPOC294600	85.59%	20.94%	64.65%
623	NA	97.94%	79.82%	18.12%
624	RPPOC430300	17.49%	2.79%	14.70%
625	RPPOC344601	99.48%	3.94%	95.53%
626	RPPOC277600	100.00%	100.00%	0.00%
627	RPPOC328600	99.99%	67.68%	32.31%
628	RPPOC294801	96.80%	17.71%	79.09%
629	RPPOC188300	97.62%	45.07%	52.55%
630	NA	96.42%	68.86%	27.56%
631	RPPOC135600	100.00%	0.89%	99.11%
632	RPPOC294701	93.64%	18.18%	75.45%
633	RPPOC188200	97.70%	48.28%	49.41%
634	RPPOC294700	90.51%	24.22%	66.29%
635	RPPOC135800	100.00%	0.67%	99.33%
636	RPPOC135901	100.00%	0.81%	99.19%
637	RPPOC135902	87.68%	13.73%	73.95%
638	NA	98.50%	83.18%	15.32%
639	NA	87.21%	48.97%	38.24%
640	RPPOC430200	48.17%	0.46%	47.71%
641	NA	98.08%	76.02%	22.06%
642	RPPOC345200	99.97%	22.34%	77.63%
643	NA	83.01%	72.93%	10.08%
644	RUPOC276900	99.99%	96.28%	3.70%
645	NA	98.03%	94.29%	3.74%
646	RPCPP111007	60.35%	0.15%	60.20%
647	NA	98.77%	95.74%	3.03%
648	NA	92.53%	67.67%	24.86%
649	RPPOC275700	100.00%	99.66%	0.34%
650	RPPOC275900	99.97%	95.74%	4.24%
651	NA	85.83%	75.21%	10.62%

652	RPPOC291700	100.00%	99.01%	0.99%
653	RPCPP108803	73.39%	48.08%	25.31%
654	RPPOC193900	92.13%	36.79%	55.34%
655	RPPOC194900	97.57%	22.30%	75.27%
656	NA	78.96%	78.46%	0.50%
657	RPPOC238300	96.72%	74.65%	22.06%
658	NA	86.54%	85.23%	1.31%
659	RPCPP112402	40.17%	0.06%	40.10%
660	RPCPP095000	51.63%	1.07%	50.56%
661	NA	90.14%	79.69%	10.45%
662	RPFRH011500	72.15%	71.79%	0.36%
663	RPFRH011600	59.69%	45.70%	13.98%
664	RPPOC292100	99.86%	97.85%	2.01%
665	NA	97.95%	76.62%	21.33%
666	RPCPP094800	52.56%	1.32%	51.24%
667	RPPOC276600	99.96%	97.52%	2.44%
668	RPPOC327800	98.84%	98.23%	0.61%
669	RPPOC290700	99.98%	13.36%	86.61%
670	NA	89.50%	64.43%	25.07%
671	RPPOC241400	84.66%	8.84%	75.83%
672	RPPOC345100	93.16%	54.44%	38.72%
673	RPPOC277000	100.00%	94.23%	5.77%
674	RPPOC277100	100.00%	98.95%	1.05%
675	NA	96.12%	78.72%	17.41%
676	RPPOC290600	100.00%	96.70%	3.30%
677	RPPOC344700	99.63%	5.10%	94.54%
678	RPPOC328100	94.90%	11.42%	83.48%
679	RPPOC343800	88.71%	22.40%	66.32%
680	NA	75.43%	70.43%	5.00%
681	RPPOC290800	97.62%	88.27%	9.35%
682	NA	95.51%	77.66%	17.85%
683	RPPOC277200	99.98%	99.38%	0.60%
684	RPPOC277300	99.94%	99.52%	0.41%
685	RPPCR000300	98.91%	51.20%	47.71%
686	NA	98.85%	89.38%	9.47%
687	RPPOC289600	97.09%	51.94%	45.15%
688	RPPOC277400	100.00%	99.71%	0.29%
689	RPPOC344400	99.58%	7.43%	92.16%
690	NA	83.19%	64.01%	19.18%
691	RPPOC277500	99.97%	99.90%	0.07%
692	RPPOC192001	99.22%	48.10%	51.12%

693	RPPOC289602	100.00%	10.86%	89.14%
694	RPPOC328700	94.59%	21.32%	73.27%
695	NA	97.21%	74.28%	22.93%
696	RPPOC344300	99.44%	98.98%	0.46%
697	NA	97.08%	70.68%	26.40%
698	NA	100.00%	78.42%	21.58%
699	NA	96.26%	4.34%	91.92%
700	RPPOC192100	97.16%	63.10%	34.07%
701	RR	99.99%	0.01%	99.98%
702	NA	97.20%	71.92%	25.28%
703	NA	73.63%	70.96%	2.67%
704	NA	83.08%	62.99%	20.09%
705	RPPOC192800	91.86%	51.53%	40.33%
706	RPPOC237900	98.41%	26.11%	72.30%
707	NA	97.85%	94.17%	3.68%
708	RPPOC278100	95.80%	4.45%	91.35%
709	NA	92.99%	64.74%	28.24%
710	RPPOC289300	83.03%	48.25%	34.78%
711	NA	91.28%	76.28%	14.99%
712	NA	87.16%	57.41%	29.75%
713	NA	99.68%	45.61%	54.06%
714	NA	90.38%	45.60%	44.78%
715	NA	86.67%	73.23%	13.44%
716	NA	99.57%	45.53%	54.04%
717	RPPOC329401	89.20%	54.75%	34.45%
718	NA	78.48%	70.70%	7.78%
719	RPPOC278200	99.82%	44.67%	55.15%
720	NA	96.49%	70.19%	26.29%
721	NA	88.74%	83.57%	5.17%
722	NA	95.28%	65.38%	29.91%
723	RPPOC206500	77.11%	31.13%	45.98%
724	NA	86.94%	77.26%	9.68%
725		99.93%	50.46%	49.47%
726	NA	90.27%	45.77%	44.50%
727	NA	92.46%	72.96%	19.51%
728	NA	95.38%	76.76%	18.63%
729	NA	96.71%	73.24%	23.47%
730	NA	96.61%	71.78%	24.82%
731	NA	85.53%	65.24%	20.29%
732	NA	90.83%	85.16%	5.67%
733	NA	85.04%	61.76%	23.29%

734	NA	82.22%	78.55%	3.68%
735	RPPOC413700	99.90%	97.73%	2.17%
736	RPPOC287700	99.92%	45.76%	54.17%
737	NA	93.73%	78.24%	15.49%
738	NA	93.11%	68.48%	24.64%
739	NA	96.20%	74.66%	21.54%
740	NA	98.06%	82.44%	15.62%
741	NA	89.93%	85.37%	4.56%
742	RPPOC195501	97.42%	52.65%	44.77%
743	NA	83.80%	80.46%	3.34%
744	RPPOC233500	92.70%	71.55%	21.14%
745	NA	92.29%	85.24%	7.05%
746	NA	94.04%	72.86%	21.18%
747	NA	88.00%	84.26%	3.74%
748	NA	98.24%	81.03%	17.21%
749	RPPOC238300	93.72%	26.07%	67.66%
750	NA	89.74%	81.88%	7.87%
751	NA	88.03%	74.91%	13.12%
752	NA	99.63%	86.02%	13.61%
753	NA	94.61%	67.55%	27.06%
754	NA	77.10%	72.89%	4.21%
755	NA	100.00%	0.06%	99.94%
756	RD	100.00%	88.94%	11.06%
757	RPCPP098600	84.14%	17.75%	66.39%
758	RPCPP105400	82.39%	21.86%	60.52%
759	RPTDV000101	96.08%	19.38%	76.70%
760	RPCPP116700	93.51%	49.89%	43.62%
761	RPCPP121900	92.29%	30.84%	61.45%
762	RPTDV000101	81.39%	37.14%	44.25%
763	RPCPP142300	100.00%	1.52%	98.48%
764	R4013014901	15.51%	0.10%	15.41%
765	RPCPP122500	70.36%	58.66%	11.70%
766	RD	98.91%	97.27%	1.64%
767	RD	100.00%	88.51%	11.49%
768	NA	99.89%	99.58%	0.31%
769	R4013004301	87.21%	83.90%	3.31%
770	RPTDV000101	76.00%	33.74%	42.26%
771	RPCPP145600	31.57%	0.56%	31.00%
772	RPCPP142232	98.38%	98.35%	0.03%
773	RPCPP139204	100.00%	98.76%	1.24%
774	RPCPP142232	100.00%	1.52%	98.48%

775	RPTDV000101	67.14%	44.09%	23.05%
776	RPTDV000101	77.08%	29.46%	47.62%
777	RPTDV000101	77.89%	31.16%	46.73%
778	RPCKE000105	16.11%	0.32%	15.78%
779	R4013015602	4.21%	0.07%	4.14%
780	RPCPP144300	99.90%	98.12%	1.78%
781	RPCPP077804	64.06%	61.68%	2.38%
782	RPCPP142607	82.14%	46.90%	35.24%
783	RCCPC034901	86.48%	11.83%	74.65%
784	RCRRS000100	83.81%	52.85%	30.96%
785	RCCPC029404	75.00%	58.12%	16.87%
786	RCBSQ000302	91.04%	65.37%	25.67%
787	RCRIS000101	81.24%	63.68%	17.56%
788	NA	98.95%	87.24%	11.71%
789	RPMCS000500	86.87%	53.57%	33.30%
790	RCBRT000200	80.11%	45.61%	34.50%
791	RCIGP000201	78.93%	63.69%	15.25%
792	RCIGP000303	70.53%	55.27%	15.26%
793	RCCPC030301	78.61%	57.68%	20.93%
794	RCCPC030400	65.05%	38.34%	26.71%
795	RPPRC000600	98.35%	36.14%	62.20%
796	RPCPP003005	79.19%	65.37%	13.82%
797	RPCPP027700	98.30%	47.06%	51.24%
798	RPBMT001207	94.21%	35.74%	58.47%
799	RCCPC034801	99.17%	13.69%	85.48%
800	RCCPC034801	95.79%	26.23%	69.56%
801	RPCPP002822	99.88%	38.78%	61.09%
802	RPCPP003207	91.10%	45.09%	46.02%
803	RPCPP015604	99.96%	97.90%	2.06%
804	RPCPP015400	90.81%	47.61%	43.20%
805	RPCPP027701	94.97%	56.24%	38.73%
806	RPCPP014000	100.00%	98.24%	1.76%
807	RPILP000800	99.01%	75.03%	23.99%
808	RPILP000500	93.38%	52.20%	41.18%
809	RPILP000100	100.00%	44.32%	55.68%
810	RCPR1000102	91.84%	41.65%	50.19%
811	RCPRM000201	85.01%	44.22%	40.79%
812	RPCPP027505	78.27%	67.64%	10.63%
813	RPCPP107207	82.98%	47.77%	35.20%
814	NA	98.12%	71.81%	26.31%
815	NA	97.48%	74.21%	23.27%

816	RPCPP107000	99.69%	98.44%	1.24%
817	RPCPP105500	76.61%	67.32%	9.29%
818	RPCPP104701	100.00%	95.73%	4.27%
819	RPCPP105802	100.00%	98.48%	1.52%
820	RPCPP103300	100.00%	99.77%	0.23%
821	RPCPP110602	85.02%	67.94%	17.08%
822		100.00%	97.25%	2.75%
823	RPTCP000300	92.70%	48.61%	44.09%
824	NA	90.26%	0.17%	90.09%
825	RPTNT012700	100.00%	99.83%	0.17%
826	RPIDS000300	65.54%	65.41%	0.13%
827	RCCYA002500	64.63%	57.02%	7.61%
828	RCCY1002800	69.09%	41.28%	27.81%
829		99.99%	97.96%	2.03%
830	RD	100.00%	99.71%	0.29%
831	RD	100.00%	99.68%	0.32%
832	RCCPC025801	1.24%	0.38%	0.86%
833	RPCPP042204	98.30%	94.16%	4.14%
834	RPCPP042207	97.36%	55.57%	41.79%
835	RD	0.09%	0.06%	0.04%
836	RPCPP142234	99.73%	96.25%	3.48%
837	RPCPP009107	79.85%	23.83%	56.02%
838	RPCPP008202	60.03%	57.20%	2.83%
839	R4013003000	0.60%	0.00%	0.60%
840	RCPM6000100	60.82%	32.85%	27.98%
841	RPCPP007920	80.45%	28.45%	52.01%
842	RPCPP007920	71.96%	63.65%	8.31%
843	RPPOC376801	93.60%	44.13%	49.46%
844	RPPOC376901	77.47%	56.87%	20.60%
845	RPCPP098200	100.00%	100.00%	0.00%
846	RPCPP100000	54.19%	51.94%	2.25%
847	RPGRF001100	97.55%	19.87%	77.68%
848	RPEA2000305	66.03%	65.18%	0.85%
849	RPVIC004600	97.15%	6.35%	90.81%
850	NA	95.73%	72.65%	23.08%
851	RPCPP112404	0.56%	0.01%	0.55%
852	RPPOC291800	100.00%	98.14%	1.86%
853	RPCPP020800	83.45%	47.22%	36.23%
854	RPCPP020800	78.84%	51.17%	27.67%
855	RPCPP020800	85.57%	39.66%	45.91%
856	RPNCS000200	78.61%	57.53%	21.08%

857	RPTAS000300	88.97%	65.43%	23.54%
858	RCTSQ000100	85.45%	59.69%	25.76%
859	RCTSQ000300	75.33%	47.33%	28.01%
860	RPOCR000200	99.98%	14.13%	85.85%
861	RPOCR000400	77.60%	45.60%	32.01%
862	RPCPP002824	96.89%	86.09%	10.80%
863	RPCPP002823	99.69%	99.60%	0.09%
864	RPCPP002812	100.00%	99.04%	0.96%
865	RPPRC000200	89.03%	45.48%	43.55%
866	RCBSQ000201	86.90%	46.76%	40.14%
867	RCBSQ000101	79.67%	51.16%	28.51%
868	RCCPC035002	86.21%	32.03%	54.18%
869	RCRIS000101	87.16%	25.74%	61.43%
870	RCRIS000203	93.99%	61.99%	31.99%
871	RCPRM000201	90.63%	56.96%	33.67%
872	RCHPS000600	80.71%	29.99%	50.72%
873		23.48%	0.05%	23.43%
874	RPPSQ001701	72.46%	52.85%	19.61%
875	RPCPP090406	79.62%	58.40%	21.22%
876	RPCPP027300	28.13%	0.37%	27.76%
877		88.30%	86.28%	2.02%
878	RPPOC216902	92.30%	52.40%	39.90%
879	RPCPP023602	95.01%	63.00%	32.01%
880	RPPRC000700	97.63%	33.54%	64.09%
881	RPPRC000300	67.82%	49.60%	18.22%
882	RPHIC000804	67.65%	56.39%	11.26%
883	RPTRI	89.17%	41.93%	47.24%
884		100.00%	100.00%	0.00%
885	RPCPP093200	94.71%	26.57%	68.15%
886	RPPSQ001403	94.10%	52.44%	41.66%
887	RPCPP063010	100.00%	93.31%	6.69%
888	RPCPP046204	77.88%	40.63%	37.25%
889	RPCPP046303	86.44%	82.82%	3.62%
890	RPHRT000101	85.15%	60.15%	25.00%
891	RPCPP030601	63.62%	57.70%	5.92%
892	RPPSQ000501	94.56%	56.66%	37.90%
893	RPHDP000100	94.16%	54.59%	39.57%
894	RPPSQ001500	87.30%	62.55%	24.75%
895	RPPSQ000402	92.33%	56.77%	35.56%
896	RPPSQ000302	89.66%	60.69%	28.96%
897	RPPSQ000200	71.94%	66.35%	5.59%

898	RPPSQ001100	88.59%	45.86%	42.73%
899	RPPOC306001	98.66%	80.59%	18.07%
900	RPIDA002300	100.00%	3.72%	96.28%
901	RPIDA002200	97.24%	10.77%	86.46%
902	RPCPP049501	100.00%	74.95%	25.05%
903	RPPMT003500	99.68%	7.36%	92.32%
904	RPCPP060600	100.00%	100.00%	0.00%
905	RPCPP073819	97.43%	10.35%	87.08%
906	RPCPP066300	100.00%	79.50%	20.50%
907	RPIDT000700	99.54%	66.96%	32.58%
908	RPMNT001200	100.00%	62.21%	37.79%
909	RPMNT001100	100.00%	56.86%	43.14%
910	RPNPB000200	100.00%	73.85%	26.15%
911	RPCPP060700	100.00%	100.00%	0.00%
912	RPCPP060700	44.64%	1.03%	43.61%
913	RPCPP074000	84.39%	60.86%	23.52%
914	RPCPP074201	97.94%	40.08%	57.86%
915	RPBNV006801	98.54%	68.42%	30.12%
916	RPIDT001400	99.65%	68.20%	31.45%
917	RPIDT002101	99.99%	41.67%	58.32%
918	RPCPP068100	89.61%	13.91%	75.70%
919	RPCPP048604	99.74%	78.33%	21.41%
920	RPBIP000100	95.99%	87.32%	8.67%
921	RPCPP071503	100.00%	29.27%	70.73%
922	RPCPP067700	95.63%	15.06%	80.57%
923	RPCPP067700	100.00%	11.72%	88.28%
924	RPCPP067700	99.84%	41.61%	58.23%
925	RPBIP000200	95.77%	50.78%	44.99%
926	RPCPP048200	99.10%	74.88%	24.23%
927	RPBIP000300	95.36%	38.70%	56.66%
928	RPCPP073811	98.92%	43.79%	55.13%
929	RPCPP066200	56.29%	49.65%	6.64%
930	RPCPP066200	59.07%	41.29%	17.78%
931	RPMNT001000	99.79%	33.98%	65.81%
932	RPCPP073812	95.70%	32.68%	63.01%
933	RPBIP000500	85.52%	58.79%	26.73%
934	RPIDL002000	97.50%	45.76%	51.74%
935	RPIDL000900	88.91%	44.17%	44.73%
936	RPIDL001402	96.19%	9.69%	86.50%
937	RPBIP000301	97.66%	48.58%	49.08%
938	RPMNT001300	93.36%	92.94%	0.43%

939	RPCPP073806	98.34%	67.23%	31.11%
940	RPCPP073806	96.01%	10.04%	85.96%
941	RPCPP073814	98.87%	71.74%	27.13%
942	RPIDL000203	91.71%	46.72%	44.99%
943	RPIDL000202	93.09%	29.71%	63.38%
944	RPIDL000401	92.30%	51.76%	40.54%
945	RPIDA001800	98.54%	93.04%	5.50%
946	RPIDA002200	91.89%	27.65%	64.25%
947	RPCPP073806	97.48%	13.69%	83.79%
948	RPMNT000606	91.87%	39.12%	52.75%
949	RPCPP049600	99.52%	65.59%	33.93%
950	RPCPP077803	73.13%	63.97%	9.17%
951	RPIDA002200	90.30%	68.17%	22.12%
952	RPMNT000400	98.01%	59.96%	38.05%
953	RPFMS000600	98.82%	43.90%	54.92%
954	RPIDA001800	100.00%	11.15%	88.85%
955	RPIDA001900	98.61%	15.89%	82.72%
956	RPIDA001500	100.00%	95.66%	4.34%
957	RPNPB000101	100.00%	75.25%	24.75%
958	RPIDA000600	96.11%	15.33%	80.78%
959	RPNPB000300	100.00%	73.19%	26.81%
960	RPNPB001101	100.00%	51.14%	48.86%
961	RPCPP078005	81.75%	63.84%	17.92%
962	RPMNT000500	100.00%	55.56%	44.44%
963	RPMNT000201	97.73%	42.93%	54.80%
964	RPIDA000500	70.04%	36.52%	33.52%
965	RPIDA000200	79.16%	74.92%	4.24%
966	RPIDA000400	75.42%	55.97%	19.45%
967	RPIDA000100	99.99%	50.06%	49.93%
968	RPCPP044846	100.00%	83.02%	16.98%
969	RPMNT000202	100.00%	62.39%	37.61%
970	RPNXT000200	90.04%	17.54%	72.49%
971	RPOLT000400	85.42%	52.87%	32.54%
972	RPOLT000400	81.21%	72.45%	8.76%
973	RPNPB001800	100.00%	99.14%	0.86%
974	RPCPP042201	100.00%	99.95%	0.05%
975	RPNPB000801	100.00%	72.28%	27.72%
976	RPCPP020200	98.79%	8.72%	90.07%
977	RPADL001100	100.00%	43.95%	56.05%
978	RPFMS000200	81.36%	39.11%	42.25%
979	RPOLT000200	99.38%	5.89%	93.49%

980	RPNXT000400	79.71%	48.45%	31.27%
981	RPNXT000100	78.28%	67.58%	10.70%
982	RPNXT002700	97.88%	86.19%	11.70%
983	RPADL001100	79.37%	27.23%	52.14%
984	RPGNA001100	91.96%	50.45%	41.52%
985	RPADL000400	74.39%	40.65%	33.74%
986	RPADL001100	98.59%	18.11%	80.48%
987	RPGNA001601	90.39%	32.15%	58.24%
988	RPADL000700	100.00%	32.79%	67.21%
989	RPCPP022300	98.79%	49.73%	49.06%
990	RPPOP000301	71.53%	70.76%	0.77%
991	RPYHA002400	98.95%	50.38%	48.57%
992	RPYHA000500	87.52%	43.08%	44.43%
993	RPSV1001503	82.99%	25.43%	57.55%
994	RPFRG002000	91.48%	80.65%	10.83%
995	RPCPP034100	61.79%	55.61%	6.17%
996	RPADL000200	88.21%	45.97%	42.24%
997	RPCPP023206	99.08%	39.95%	59.14%
998	RPCPP020200	97.10%	46.28%	50.82%
999	RPCPP020200	100.00%	8.84%	91.16%
1000	RPCPP020200	98.40%	59.52%	38.88%
1001	RPGNA001000	99.96%	47.69%	52.27%
1002	RPGNA000800	99.99%	60.29%	39.70%
1003	RPADL000100	71.25%	48.76%	22.49%
1004	RPGNA001301	82.88%	40.40%	42.47%
1005	RPGNA001302	93.86%	18.10%	75.76%
1006	RPGNA001200	92.84%	13.66%	79.17%
1007	RPCPP020200	98.12%	26.15%	71.97%
1008	RPCPP020200	81.65%	29.94%	51.71%
1009	RPCPP020200	100.00%	70.77%	29.23%
1010	RPGNA000900	99.86%	42.26%	57.60%
1011	RPCPP042201	96.80%	27.90%	68.90%
1012	RPCPP020200	99.41%	4.33%	95.08%
1013	RPCPP020200	100.00%	95.55%	4.45%
1014	RPCPP020200	82.65%	26.03%	56.62%
1015	RPCPP023216	88.58%	61.36%	27.22%
1016	RPCPP020200	92.49%	41.63%	50.86%
1017	RPCPP020200	71.57%	49.48%	22.09%
1018	RPCPP019902	60.47%	49.72%	10.75%
1019	RPCPP023218	93.91%	67.89%	26.02%
1020	RPCPP020200	88.02%	53.33%	34.69%

1021	RPCPP011806	87.05%	50.59%	36.46%
1022	RPTAS001000	100.00%	98.96%	1.04%
1023	RPTAS000901	99.85%	99.30%	0.55%
1024	RPCPP020200	100.00%	1.08%	98.92%
1025	RPIDA002900	78.73%	68.65%	10.08%
1026	RPYHA001500	92.87%	51.75%	41.12%
1027	RPTAS004300	91.10%	31.40%	59.70%
1028	RPYHA001200	91.28%	36.48%	54.80%
1029	RPCPP004803	83.44%	59.21%	24.24%
1030	RPFRG003000	64.57%	44.60%	19.97%
1031	RPYHA002300	88.75%	72.07%	16.68%
1032	RPFRG000102	95.58%	30.89%	64.69%
1033	RPSV1005402	90.77%	51.09%	39.68%
1034	RPHO1004011	73.30%	57.16%	16.14%
1035	RPFRG001901	89.01%	58.31%	30.70%
1036	RPSV1001503	82.97%	31.24%	51.73%
1037	RPFRG002300	87.91%	22.59%	65.32%
1038	RPTAS003602	85.15%	45.45%	39.71%
1039	RPSV1005403	72.35%	54.72%	17.63%
1040	RPFRG002200	86.67%	24.83%	61.84%
1041	RPFRG002101	92.06%	22.59%	69.48%
1042	RPFRG002400	87.78%	24.76%	63.02%
1043	RPPLT000400	94.78%	66.87%	27.91%
1044	RPSV1005405	81.76%	48.10%	33.66%
1045	RPCPP012107	86.64%	33.09%	53.55%
1046	RPFRG003601	82.36%	63.32%	19.04%
1047	RPFRG003501	94.76%	65.84%	28.91%
1048	RPCPP015307	80.51%	30.15%	50.35%
1049	RPCPP012200	78.75%	61.30%	17.44%
1050	RPCPP012200	80.50%	37.97%	42.53%
1051	RPCPP012103	82.63%	48.32%	34.30%
1052	RPCPP015308	86.15%	31.56%	54.59%
1053	RPCPP014300	77.64%	76.83%	0.81%
1054	RPEA2000304	71.59%	55.67%	15.93%
1055	RPEA2000306	84.18%	61.98%	22.19%
1056	RPARC000100	75.61%	58.30%	17.31%
1057	RPILP000700	97.90%	77.64%	20.27%
1058	RPCPP027800	78.55%	51.71%	26.84%
1059	RPCPP027300	36.61%	0.73%	35.88%
1060	RPCPP014201	89.00%	85.88%	3.11%
1061	RPCPP004606	83.31%	53.33%	29.99%

1062	R3851001709	84.48%	18.96%	65.52%
1063	RPGR2001100	73.76%	58.88%	14.88%
1064	RPCPP073818	99.87%	80.60%	19.27%
1065	RPCPP073816	92.07%	58.53%	33.54%
1066	RPGWD001800	100.00%	68.92%	31.08%
1067	RPPOC114000	97.75%	28.37%	69.39%
1068	RPCPP053002	97.95%	26.51%	71.44%
1069	RPCPP063508	92.70%	40.37%	52.34%
1070	RPTHD000800	74.19%	25.29%	48.90%
1071	RPFRV004600	91.62%	36.64%	54.98%
1072	RPCPP063301	100.00%	29.98%	70.02%
1073	RPFRV007600	99.04%	51.69%	47.35%
1074	RPCPP063504	100.00%	26.88%	73.12%
1075	RPCPP063203	100.00%	88.86%	11.14%
1076	RPTHD000500	86.31%	51.79%	34.52%
1077	RPGVC003800	88.21%	34.63%	53.58%
1078	RPGVC003900	100.00%	83.04%	16.96%
1079	RPGRA004300	99.94%	36.27%	63.67%
1080	RPCPP063309	92.55%	31.42%	61.13%
1081	RPGVC004000	100.00%	8.05%	91.95%
1082	RPCPP063305	99.87%	33.12%	66.76%
1083	RPFRV007400	98.91%	25.80%	73.11%
1084	RPPOC018000	90.04%	49.78%	40.26%
1085	RPGRA004201	93.14%	22.27%	70.87%
1086	RPCPP063306	80.58%	55.67%	24.92%
1087	RR	99.83%	99.46%	0.36%
1088	RPPOC113800	77.40%	35.45%	41.95%
1089	RPPOC114000	73.00%	40.42%	32.58%
1090	RPPOC002800	71.03%	54.05%	16.98%
1091	RPPOC115000	89.36%	42.16%	47.20%
1092	RPPOC151800	96.94%	45.22%	51.72%
1093	RPPOC255415	99.99%	99.88%	0.11%
1094	RPPOC018600	93.94%	19.27%	74.67%
1095	RPPOC247000	73.47%	63.89%	9.57%
1096	RPPOC115700	96.37%	66.17%	30.19%
1097	RPPOC009700	90.49%	34.70%	55.79%
1098	RPPOC246901	80.99%	70.66%	10.33%
1099	RPPOC246901	82.43%	52.61%	29.82%
1100	RPPOC305701	77.38%	63.21%	14.17%
1101	RPPOC247000	82.09%	41.76%	40.34%
1102	RPPOC254900	83.26%	40.81%	42.45%

1103	RPPOC177900	89.97%	29.41%	60.55%
1104	RPPOC260101	99.91%	73.18%	26.73%
1105	RPPOC261600	64.00%	57.54%	6.46%
1106	RPPOC272000	99.50%	60.35%	39.14%
1107	RPPOC260101	99.92%	41.36%	58.56%
1108	RPPOC260101	100.00%	82.34%	17.66%
1109	RPPOC260101	99.97%	71.61%	28.36%
1110	RPPOC305000	99.20%	36.75%	62.45%
1111	RPPOC305200	98.67%	36.46%	62.22%
1112	RPPOC305900	100.00%	98.16%	1.84%
1113	RPPOC305800	99.96%	93.61%	6.35%
1114	RPPOC263000	99.10%	91.68%	7.43%
1115	RPPOC305100	97.16%	40.71%	56.45%
1116	RPPOC177800	94.30%	29.75%	64.55%
1117	RPPOC177700	85.18%	61.29%	23.89%
1118	RPPOC184800	99.48%	3.78%	95.69%
1119	RPCT1001700	43.18%	0.46%	42.72%
1120	RPPOC251900	99.64%	98.41%	1.24%
1121	RPPOC182100	99.43%	39.87%	59.56%
1122	RPPOC182200	99.40%	29.25%	70.15%
1123	RPPOC269000	94.27%	10.93%	83.33%
1124	RPPOC269500	96.62%	3.64%	92.97%
1125	RPPOC124700	81.37%	25.53%	55.84%
1126	RPPOC182300	88.13%	12.82%	75.31%
1127	RPPOC182500	93.35%	43.74%	49.61%
1128	RPPOC182400	94.88%	15.66%	79.22%
1129	RPCPP111005	25.68%	0.00%	25.68%
1130	RPPOC158802	95.04%	37.51%	57.54%
1131	RPPOC299201	92.11%	43.74%	48.37%
1132	RPPOC270900	99.63%	98.45%	1.18%
1133	RPPOC269100	97.76%	4.15%	93.60%
1134	RPPOC269200	97.96%	3.64%	94.32%
1135	RPCPP110400	90.47%	76.08%	14.39%
1136	RPPOC269300	78.30%	29.55%	48.75%
1137	RPPOC269600	93.44%	10.56%	82.87%
1138	RPPOC269400	83.50%	24.58%	58.92%
1139	RPPOC184500	99.40%	49.21%	50.19%
1140	RPPOC271200	99.51%	99.09%	0.41%
1141	RPPOC216901	98.50%	52.11%	46.39%
1142	RPPOC184900	88.58%	60.08%	28.50%
1143	RPPOC186400	87.95%	53.33%	34.62%

1144	RPPOC188900	97.47%	73.90%	23.58%
1145	RPPOC271900	98.89%	8.97%	89.92%
1146	RPPOC277700	99.56%	35.05%	64.51%
1147	RPPOC271800	96.97%	17.79%	79.19%
1148	RPPOC292800	90.67%	17.24%	73.43%
1149	RPPOC276200	99.80%	95.93%	3.87%
1150	R3851027700	0.13%	0.03%	0.11%
1151	RPPOC328400	99.15%	95.43%	3.72%
1152	RPPOC289700	95.06%	48.12%	46.94%
1153	RPPOC225300	99.95%	99.78%	0.17%
1154	RPPOC214600	95.08%	12.75%	82.33%
1155	RPPOC225400	95.69%	8.37%	87.32%
1156	RPPOC214600	100.00%	10.31%	89.69%
1157	RPPOC326602	97.95%	92.64%	5.31%
1158	RPPOC188500	84.95%	47.24%	37.71%
1159	RPPOC276800	100.00%	96.98%	3.02%
1160	RPPOC192200	79.73%	66.61%	13.12%
1161	RPPOC415000	75.39%	38.04%	37.35%
1162	RPPOC228602	92.66%	43.25%	49.41%
1163	RPPOC211000	99.57%	28.12%	71.45%
1164	RPPOC211100	100.00%	3.14%	96.86%
1165	RPPOC292200	93.15%	66.55%	26.60%
1166	RPPOC292000	99.78%	98.64%	1.14%
1167	RPPOC276700	99.43%	97.45%	1.98%
1168	RPPOC328000	98.74%	98.72%	0.01%
1169	RPPOC229601	61.76%	56.31%	5.45%
1170	RPPOC241000	90.63%	20.48%	70.15%
1171	RPPOC328500	98.17%	1.14%	97.03%
1172	RPPOC277800	98.82%	63.10%	35.71%
1173	RPPOC328800	100.00%	18.00%	82.00%
1174	RPPOC277900	97.82%	5.12%	92.70%
1175	RPPOC386200	67.22%	54.67%	12.55%
1176	RPPOC192100	99.60%	2.12%	97.47%
1177	RPPOC329200	98.96%	60.33%	38.63%
1178	RPPOC380300	99.64%	98.02%	1.62%
1179	RPPOC329800	99.64%	40.73%	58.91%
1180	RPPOC329300	97.71%	71.78%	25.93%
1181	RPPOC383500	100.00%	2.93%	97.07%
1182	RPPOC341700	98.59%	20.55%	78.04%
1183	RPPOC329900	98.43%	95.83%	2.60%
1184	RPPOC329700	85.75%	23.35%	62.39%

1185	RPPOC329600	84.05%	21.79%	62.26%
1186	RPPOC195301	98.08%	19.94%	78.14%
1187	RPPOC195401	79.32%	75.82%	3.50%
1188	RPPOC195301	100.00%	18.46%	81.54%
1189	RPPOC195601	99.78%	18.60%	81.17%
1190	RPPOC195601	64.88%	48.56%	16.32%
1191	RPPOC238000	100.00%	2.72%	97.28%
1192	RPPMT003600	98.88%	63.78%	35.10%
1193	RPCPP106401	53.19%	0.01%	53.18%
1194	RPCPP104600	83.91%	65.59%	18.33%
1195	RPCPP121700	87.94%	36.20%	51.74%
1196	RPCPP106801	93.69%	17.10%	76.59%
1197	RPCPP115301	97.95%	24.34%	73.61%
1198	RPCPP129700	49.01%	0.03%	48.98%
1199	RPCPP122600	88.21%	77.69%	10.52%
1200	RPCPP002402	97.62%	95.70%	1.92%
1201	RPILP000101	99.69%	26.89%	72.79%
1202	RPGVC003201	86.70%	33.61%	53.09%
1203	RPHRT000101	99.16%	11.14%	88.01%
1204	RPCPP002206	95.31%	33.66%	61.64%
1205	RPPRC000100	93.14%	41.53%	51.61%
1206	RPCPP015702	84.67%	54.78%	29.89%
1207	RPCPP002816	81.11%	51.83%	29.28%
1208	RPCPP101700	84.64%	48.14%	36.50%
1209	RPGOP000800	87.61%	53.30%	34.31%
1210	RPBMT000606	97.41%	49.25%	48.16%
1211	RPCPP106201	99.88%	96.15%	3.73%
1212	RPBCS000100	79.55%	58.93%	20.62%
1213	RPCPP105801	76.72%	56.41%	20.31%
1214	RPCPP106000	100.00%	99.99%	0.01%
1215	RPCPP115302	99.95%	99.83%	0.11%
1216	RPCPP142289	92.14%	83.85%	8.29%
1217	RPCPP042205	87.63%	66.79%	20.85%
1218	RPCPP042910	87.29%	66.38%	20.90%
1219	R4013004302	71.39%	42.46%	28.94%
1220	RPCPP104402	70.63%	58.82%	11.81%
1221	RPCPP105304	70.23%	62.14%	8.09%
1222	RPPSQ001300	99.34%	55.70%	43.64%
1223	RPPP1000100	74.68%	63.80%	10.87%
1224	RPPP1000200	78.87%	58.11%	20.75%
1225	RPPP2000100	65.19%	63.26%	1.93%

1226	RPCPP142001	77.63%	35.74%	41.89%
1227	R4013004400	73.58%	32.63%	40.95%
1228	RPSCS000200	84.29%	40.84%	43.46%
1229	RPBRP000104	99.88%	74.19%	25.69%
1230	RPGOP000200	96.17%	94.00%	2.17%
1231	RPGNA000800	99.96%	32.55%	67.41%
1233	RPCT1001800	43.57%	0.44%	43.12%
1234	RPPOC241300	96.74%	33.92%	62.81%
1235	RPTCP000200	67.54%	41.42%	26.11%
1236	RPTCP000701	69.23%	61.40%	7.83%
1237	RPTCP000100	94.01%	49.99%	44.02%
1238	RPTCP000601	71.86%	57.96%	13.91%
1239	RPOHR000400	70.94%	46.64%	24.31%
1240	RPCPP105303	73.92%	64.51%	9.41%
1241	RPWAS001400	50.62%	49.65%	0.96%
1242	RPGWC000100	80.78%	43.76%	37.02%
1243	RPAR1001500	80.93%	27.69%	53.24%
1244		96.45%	90.26%	6.18%
1245		98.38%	89.69%	8.69%
1246	RPNPB001300	100.00%	64.44%	35.56%
1247	RPPOP000500	62.16%	60.77%	1.39%
1248	RPTAS001502	96.21%	43.35%	52.85%
1249	RPYHA000601	88.38%	49.38%	39.00%
1250	RPIDL002902	97.25%	54.66%	42.60%
1251	RPIDL002901	100.00%	40.08%	59.92%
1252	RPPOC027801	88.58%	61.60%	26.98%
1253	RPPOC178502	100.00%	68.94%	31.06%
1254	RPPOC173601	85.40%	50.53%	34.87%
1255	RPTNT000104	90.12%	37.26%	52.86%
1256	RPCPP086133	62.00%	50.11%	11.88%
1257	RPCPP002821	65.29%	58.57%	6.72%
1258	RPPRC000500	77.05%	57.33%	19.72%
1259	RPPRC000400	78.35%	42.42%	35.92%
1260	RPBMT000606	94.49%	45.17%	49.32%
1261	RPCPP086202	76.22%	44.84%	31.39%
1262	RPCPP086134	95.68%	31.29%	64.38%
1263	RPCPP086119	99.37%	11.09%	88.28%
1264	RPPSQ001411	80.91%	55.64%	25.26%
1265	RPPSQ001410	63.52%	54.68%	8.83%
1266	RPCPP003206	70.84%	39.89%	30.95%
1267	RPTNT000103	83.59%	64.57%	19.02%

1268	RPTAS004702	77.54%	70.07%	7.46%
1269	RPCPP086135	96.15%	8.33%	87.83%
1271	RPPOC158801	99.26%	42.66%	56.59%
1272	RPCPP048605	100.00%	64.55%	35.45%
1273	RPFRG000101	86.63%	39.51%	47.11%
1274	RPCPP044700	40.77%	0.17%	40.61%
1275	RPHAW000100	66.91%	62.36%	4.55%
1276	RPPOC291503	100.00%	98.55%	1.45%
1277		96.78%	92.85%	3.93%
1278		10.70%	0.12%	10.58%
1279		0.41%	0.10%	0.31%
1280		50.13%	0.05%	50.09%
1281	RPCPP142241	46.27%	0.02%	46.25%