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Hinterland Ecosystem Services Supply for Urban Residents: Application of Heckmans Two Stage Model for Contingent Valuation Study in Mekelle City

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Abstract: Ecosystems provide a slew of benefits, ranging from supporting social and economic growth to mitigating and adapting to climate change. Hinterland ecosystem services are vital for rapidly urbanizing areas, and the people who live within them. The ecosystem services used up in Mekelle city are provided from the adjacent hinterlands. The current situation indicates that the hinterland ecosystem services supply sources and willingness to pay for its sustainable provision of ecosystem services remain unknown. This study was conducted to offer policy decision making and achieve an improved understanding of the causal relationships between the urban residents' willingness-to pay and hinterland ecosystem services sources. Household survey with 384 urban residents from seven Mekelle's sub-cities was conducted. The study applied Heckman's two stage model using STATA to analyze the factors affecting the residents' WTP. To study hinterland ecosystem services satellite images were used and were analysed using ERDAS imagine 15 and ArcGIS 10.5.1. The results exposed that 91.7% of the studied respondents are willing to pay for hinterland ecosystem services supply and had an average WTP of 2.21 USD per month. This could additionally enhance the perceptions of urban residents on ecosystem services. The factors that significantly influence WTP include variables M1 (years of stay in Mekelle city), M2 (Sex), occupation (M9), income (M10), family size (M11), water quantity (M12), water reliability (M13) and ecosystem services value recognition (M15). With regard to payout levels, the influencing factors include M1 (Years of stay in Mekelle city), M2 (sex), M9 (Occupation), M10 (Monthly income of your household), M11 (Family size), M12 (Water quantity), M13 (Water reliability) and M15 (Ecosystem services value recognition) are significantly related to WTP and payout levels. The results of this empirical study could help policy makers to understand better the ways to enhance ecosystem services supply for urban areas from hinterland ecosystem services and to identify effective policy instruments.

Keywords: Ecosystem Services, Hinterland, Heckmans Two Stage Model, Remote Sensing, Contingent Valuation Method

1. Introduction

Humanity is becoming more urbanized, but it still relies on nature for survival [3]. The supply of ecosystem goods and services in urban areas is a critical concern [7]. Cities can no longer be divorced from a comprehensive grasp of their ecological underpinnings. Metropolitan populations and economy rely on resources from the hinterlands, however there is a gap between consuming resources for urban regions and sustaining and protecting ecosystem functions outside of cities [5].

Humans gain from ecosystem services in a variety of ways. Nature's contributions to basic requirements, such as food production, water provisioning, fuel and fiber provisioning, and climate, water, and nutrient cycling control, as well as supporting services that provide the conditions for all other provisioning, regulating, and cultural services [4]. The hinterlands, or rural areas around cities, are linked to them as a source of ecosystem services that benefit urban areas. The ecosystem services supplied by the city's hinterlands to metropolitan centers range from essential food and water

supply to less visible necessities like climate regulation, air filtration, and recreation [9]. As the world's population, production, and consumption grow increasingly concentrated in cities, the need for more environmentally friendly urban development patterns becomes clear [18].

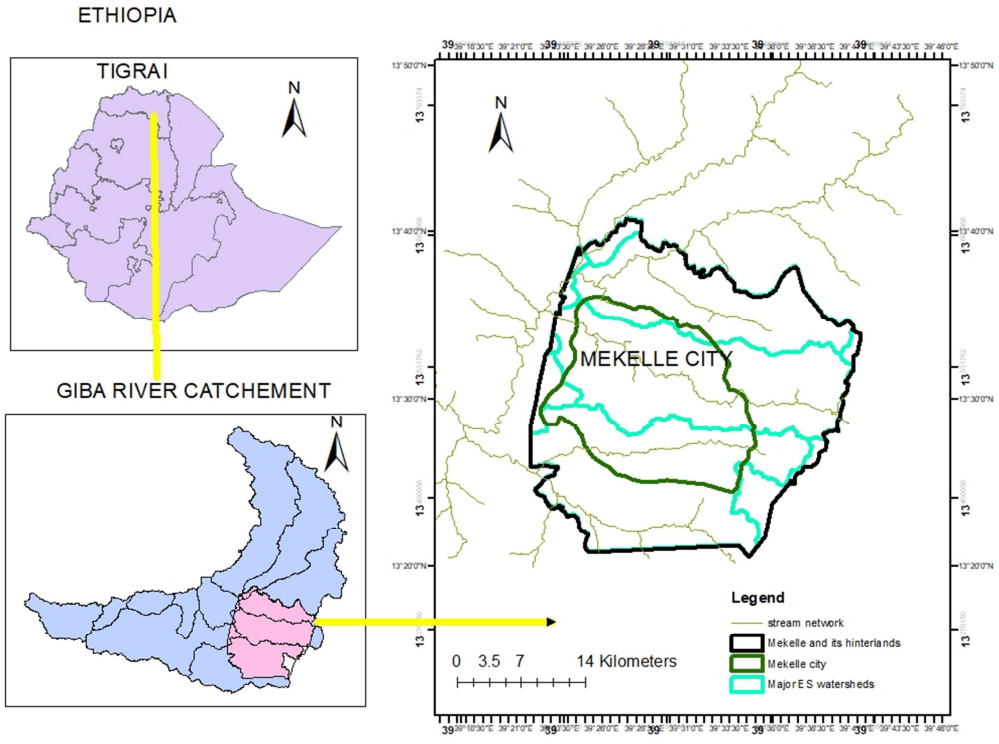
In this era of globalization and increased urbanization, it is becoming increasingly clear that cities and their environs will play a critical role in defining and addressing future sustainability concerns [22]. The demand for ecosystem services far outweighs local capacity to produce them, leading cities to consume resources from ecosystems outside the city boundary [8]. The ecosystem services provided by peri-urban ecosystems and peri-urban agriculture are important in a variety of areas of urban sustainability and resilience, from food security to catastrophe risk reduction. Despite this, the ecosystems on which these services rely are increasingly threatened and are frequently disregarded in policy and planning [16].

People's perception of what prevents them from reaping the benefits of ecosystem services can reveal how these benefits differ among socioeconomic groupings. For equitable environmental management, a socially differentiated approach to analyzing ecosystem service benefits is critical [14]. Perceptions are interpretations, and for the most part, interpretations become the truth for most people. As a result, perceptions have a huge impact on human mind and behavior. Individuals and communities see entities in a variety of ways, depending on their life contexts and circumstances [20]. In this study, perception is referred to as spontaneous knowledge or awareness of ecosystem services.

Mekelle city is rapidly growing in size, and the surrounding peri-urban areas are being absorbed into the developed environment, posing a threat to ecosystem services. The peri-urban ecosystems are under jeopardy, and natural resources are being depleted. The availability of ecological services is dwindling. The city of Mekelle and its environs are currently witnessing fast population increase, urban sprawl, and industrial expansion. The majority of Mekelle's ecosystem services supply originates from the hinterlands, which are located outside the city's administrative boundaries. It is critical to involve local inhabitants' perceptions and preferences for ecosystem services and biodiversity in decision-making to make environmental management decisions more executive and targeted [24]. Accordingly, it is necessary and urgent to study the willingness of the urban residents, who are the direct stakeholders, to pay for the protection of the environment of Mekelle city hinterland ecosystem services. Therefore, studying hinterland ecosystem services supply sources that affect households' willingness to participate in ecosystem conservation practices can support decision-making to design policies that can improve sustainable provision of ecosystem services.

2. Materials and Methods

2.1. Study Area

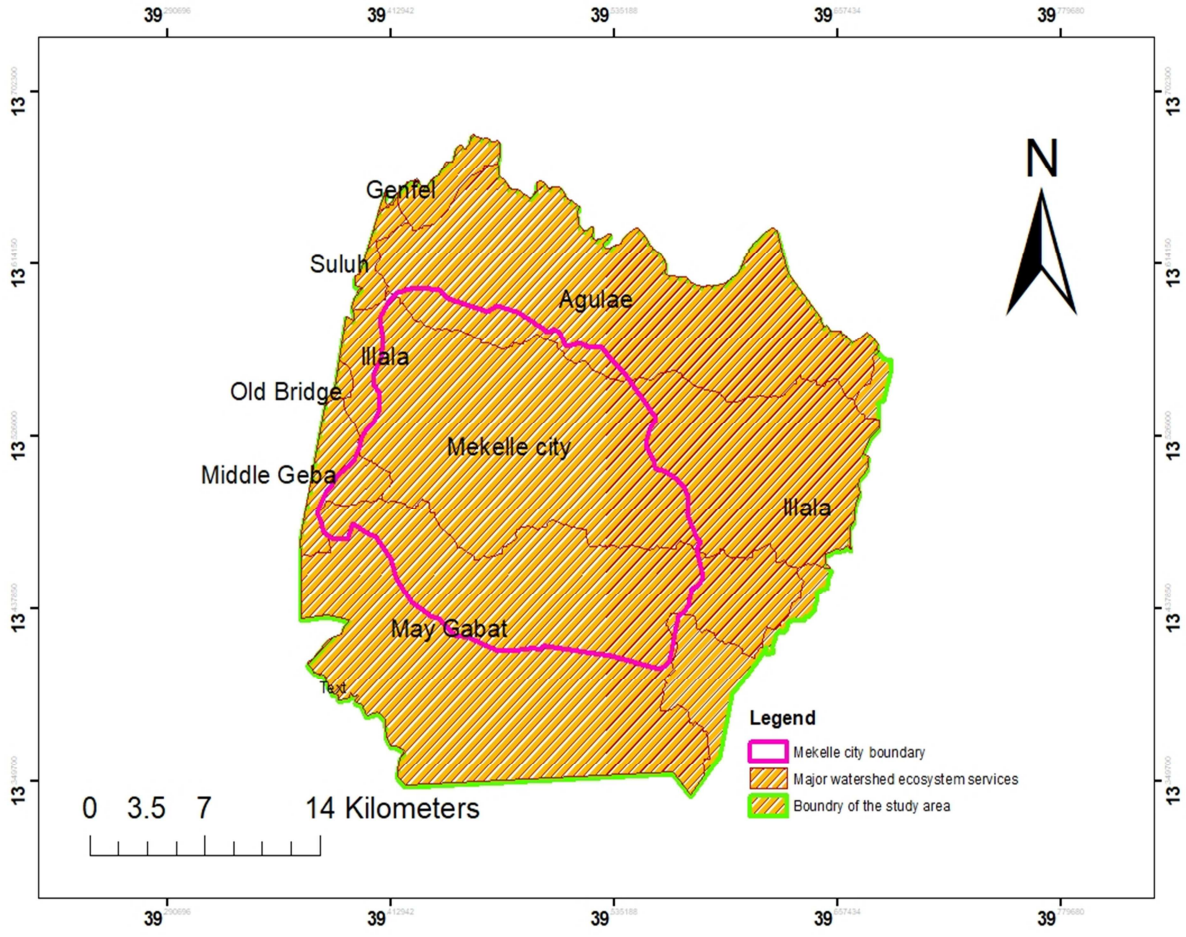


Source: Author, 2019

Figure 1. *Map of the study area.*

The study area is located within Tigray regional state, Ethiopia which is found in west 39.362942, East 39.687048, North 13.680920 and south 13.342621 and the area covered in this investigation is 897.12 square kilometers (figure 1). It is found on the north-eastern part of the central plateau west of the rift valley [1]. Mekelle city is the capital of Tigray, geographically located between 13°32'N latitude and 39°28'E longitude. The study area is characterized by different topographic conditions. The elevation ranges from 1800 in the Geba river to 2800 Illala and Gebat river catchment and 3200 in some part of the study in Genfel and suluh. Mekelle city is 2062 m above sea level.

Mekelle city is currently mounting rapidly with large agricultural areas being encroached by the urban settlement. It is currently subdivided into seven local administrative units known as sub-city, which are responsible for municipal and administrative functions within their boundaries [19]. The main city and towns in the study area are Mekelle, Maimekeden, Meremeyti, and Aragure with a total urban population of 434,970 from the total study area population of 556,127 and the rest 121,157 population live in a rural area [23]. The data show 78.21% population live in urban centre. Agriculture and livestock are the mainstay of the economy in the rural areas of the study area [15].



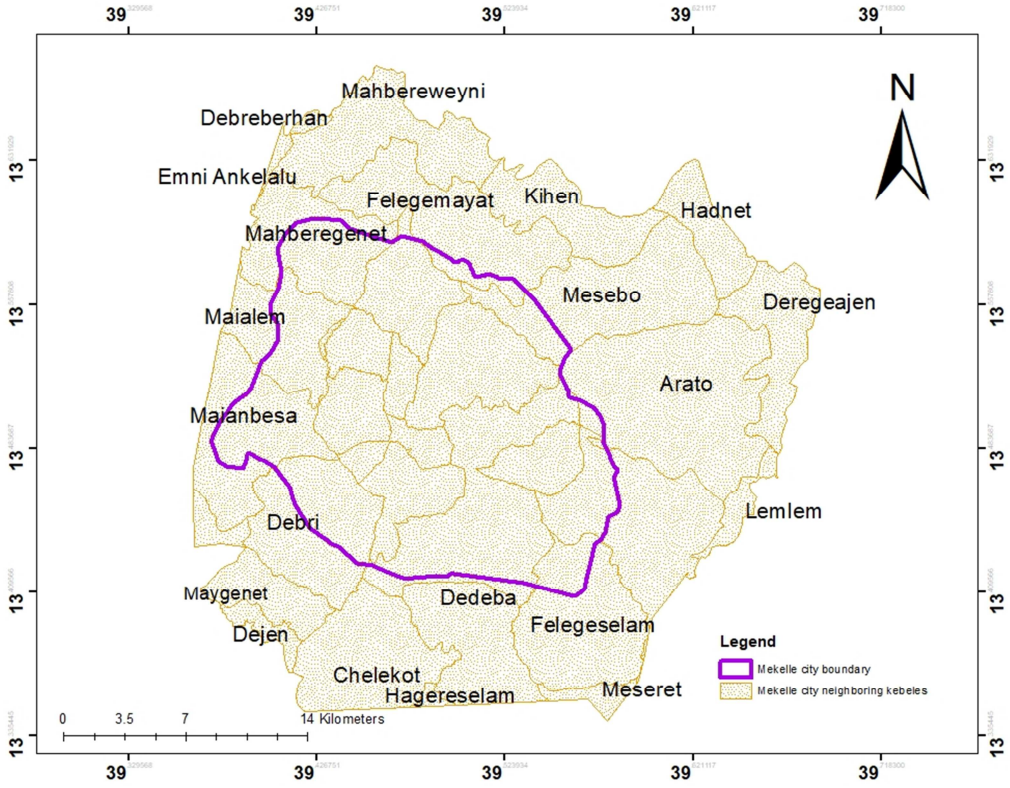
Source: Author, 2019

Figure 2. *Map of the major watershed ecosystem services in the study area.*

The above figure shows lists of major watersheds in the urban center and its hinterland. Currently, out of the 89,712 hectares of watershed areas in the study area, only about 15,383 hectares are covered with green vegetation namely natural forest (106 ha), plantation forest (497 ha), bushes and shrubs (13215 ha), grassland (330 ha) and riverside vegetation (1235 ha). The rest are cultivated land, built-up area, and water bodies. This has resulted in substantial impacts to downstream areas for sustainable provision of ecosystem services.

The beneficiaries of ecosystem services are located outside of the actual ecosystem services provision sources (Figure 3). Mekelle city gets Omni-directional ES exist in every direction of the city. The ecosystem services are produced in all directions of the surrounding rural hinterlands. The maps reveal a clear pattern of supply areas for each ESs from the rural kebeles. The areas with the highest demand for ES are in Mekelle city and nearby peri-urban areas. Many goods and services are imported from distant areas. Mekelle city is surrounded by 21 rural kebeles which are significant for ecosystem services provision for the urban population. There is growing dependance on distant catchment sources to meet

requirements such as freshwater, food, fresh air, and other ecosystem services.



Source: Author based on Tigray kebeles shapefile, 2020

Figure 3. *Map of kebele's surrounding Mekelle city.*

Parameters used to delimit Mekelle city and its hinterland

Defining Mekelle city and its hinterland was one of the important tasks undertaken in this study. The identification of the hinterland was decided during the discussion made with multi-disciplinary professionals of the study area, field survey and literature review. Different criteria were used to decide the hinterland of Mekelle city. These are: geographical proximity, administrative catchment, watersheds that provide ecosystem services, adjacent areas adversely affected or that can be affected by urban development and expansion of Mekelle city and the Bio-region; a region defined by characteristics of the natural environment rather than by man-made demarcations.

2.2. Data Sources and Research Methods

Contingent Valuation Method

Contingent valuation method was applied to acquire the willingness to pay of sampled households. A well-designed administered willingness-to-pay questionnaire to obtain information on distant ecosystem service value of Mekelle city residents was employed. The CVM was used to value ecosystem services. The draft questionnaire pre-testing was conducted in each sub-city by selecting a random sample household from each sub-cities which was done by four experienced data enumerators. The pre-test provided some information to make some adjustments in the design of the final survey questionnaire based on the responses to make it understandable for respondents.

The contingent valuation method utilized to investigate empirically the willingness to pay towards ecosystem services conservation. The design of the contingent valuation study used to elicit willingness to pay of respondents was done using NOAA. As per the population projection for the year 2019 by CSA Mekelle city had a total population of 423,174. Sample size determination formula developed by [13] was used. It was calculated as follows;

$$S = X^2 NP(1-P)/$$

$$d^2(N-1) + X^2 P(1-P)$$

All the questionnaires were proportionally distributed to households by sub-city Mekelle city residents are beneficiaries of upstream watershed ecosystem services. Therefore, seven sub-cities of the study area are purposely selected for the Study namely; Hawelti, Hadnet, Kedamaye weyane, Kuha, Ayder, Semen, and Adi-haki. The list of household respondents was generated from roasters of kebele administration through systematic sampling to form the sampling frame (Figure 4).

For the household survey, the scope of the population was considered to be all beneficiaries of the watershed ecosystem services for the city of Mekelle. The beneficiary list consisted of 423,174 city residents. Multi-stage sampling was applied to seven Mekelle's sub-cities. In the first stage, all sub-cities

were chosen in Mekelle city. Then simple random sampling was used for the selection of 28 kebeles of 4 from each sub-city randomly as there were no major differences among the kebele's in terms of ecosystem services demand. Then third stage units where household head was selected and 384 households were surveyed based on sample size determined using a systematic sampling method.

Table 1. *Sampling methods.*

Stage	Sampling Unit	Number	Method
First	Sub-cities	7	Multi-stage sampling
Second	Kebeles	28	Simple random sampling
Third	Households	384	systematic sampling method

This study utilized remote sensing data. The continuing record of changes about the LULC data in Mekelle urban centre and its hinterland was extracted and downloaded from the Landsat series of USGS and NASA which is found at earth explorer (http://earthexplorer.usgs.gov). Field observation and remote sensing are used to measure and evaluate ES at different levels [6]. The primary source of data was generated on a first-hand basis from the analysis of satellite images. Besides, observations were made and described what was observed. The primary data was also obtained by field surveys.

2.3. Data Analysis

Heckmans two stage model

Contingent valuation method (CVM) which is a survey-based technique was utilized to elicit information on willingness to pay for sustainable provision for hinterland ecosystem services supply by Mekelle city residents. The study applied Heckman's two stage model to scrutinize a proposed causal relationship among urban residents' WTP on hinterland ecosystem services supply for the ecosystem conservation.

Model selection

The WTP of residents in this study are divided into two stages. The first stage is the behavioral decision stage, when the households choose whether or not to pay for environmental protection. Residents who do not have the willingness to pay are terminated as the object of the next phase of the study, and the households who have the willingness to pay enter the second stage. The second stage is the payout level of the decision-making stage, which is the payout level of the residents who are willing to pay. Hence, this study uses Heckman's two-stage model to analyze the influencing factors of residents' WTP and their payout level, respectively.

The model is expressed as follows and contains two sub-models (Model 1 and Model 2). Model 1 is a Probit model, which examines the impacting factors for Mekelle city residents of the hinterland ecosystem services supply sources who are willing to pay. The specific model is shown below.

$$Y= \mu_0+ \mu_1M_1+ \mu_2M2+ \mu3M_3+\ldots+ \mu_nM_n+\theta$$

In Equation (2), Y is the explained variable; M1, M2, M3, …… Mn are the explanatory variables; and mo, m1, m2, m3, …….. mn are the solve for parameters; q being the residual parameter.

Model 2 is a multiple linear regression model, which mainly examines the factors that influence the residents' WTP. The specific model is as follows:

$$T= \varphi_0+\varphi_1M_1+\varphi_2M_2+\varphi_3M_3+\ldots. +\varphi_n M_n+\Sigma\Lambda +\delta$$

On the basis of literatures and the specific local situation of the study area, 16 variables were designed to evaluate the changes in the residents' WTP and their payout level.

To study distant ecosystem services satellite images were used and were analysed using ERDAS imagine 15 and ArcGIS. Digital satellite images were processed, classified, and analyzed using ERDAS Imagine remote sensing software package. The classified data into each category of land use/land cover were further analyzed for change detection. Computations of the area and land use land cover categories made using Arc GIS 10.5.1 analytical tools.

Table 2. *Variables' description and interpretation.*

Independent Variable	Unit assignment	Description
Years of stay in Mekelle city (M1)	Number of years	The author explored whether households' information have an impact on the perception of hinterland ecosystem services supply and their WTP
Sex (M2)	Male = 1, Female = 2	
Education level (M3-M8)		
Non-literate (M3)	1 = non-literate,0= otherwise	
Read and write (M4)	1 = Read and write,0 =otherwise	
Grade1-6 (M5)	1 =Grade1-6), 0= otherwise	
Junior secondary/ grade 7-8 (M6)	1 = Junior secondary 0 =otherwise	
Grade 9-12 (M7)	1 = Grade 9-12), 0 =otherwise	
Tertiary level (M8)	1 = Tertiary, 0 =otherwise	
Occupation (M9)	Unemployed=1, Housewife=2 Self-employed=3, Farmer=4 Government employee=5, Private employee=6 Laborer=7, Retired=8, NGOs=9	
Monthly income of your household (M10)	In birr currency	The author investigated whether household information influences the resident's ability to pay for hinterland ecosystem services
Family size (M11)	Persons	
Water quantity (M12)	High=1, Fair=2, Poor=3	The author examined whether the degree of satisfaction

Independent Variable	Unit assignment	Description
Water reliability (M13)	Reliable=1, Unreliable=2	of the residents for water quality, quantity and reliability affect the urban residents' WTP for hinterland ecosystem services
Water quality (M14)	Good=1,2= Fair, Poor=3	
Ecosystem services value recognition (M15)	Aware=1, Not aware=2	Awareness of city residents on distant ecosystem services supply
Dependent variable		
Willingness to pay (M16)	Yes=1, No=2	Urban residents' willingness to pay for hinterland ecosystem services

Table 3. *Descriptive statistics for the selected study variables.*

Variable	Obs	Mean Std.	Std. Dev.	Min	Max
M1	384	21.22656	11.8959	1	50
M2	384	0.611979	0.487935	0	1
M3	384	0.226563	0.419153	0	1
M4	384	0.065104	0.247031	0	1
M5	384	0.135417	0.342615	0	1
M6	384	0.151042	0.358557	0	1
M7	384	0.203125	0.40285	0	1
M8	384	0.216146	0.412152	0	1
M9	384	0.721354	0.448918	0	1
M10	384	3839.516	1992.362	300	15000
M11	384	3.304688	1.810436	0	8
M12	384	1.8125	0.390822	1	2
M13	384	0.721354	0.448918	0	1
M14	384	0.677083	0.49	0	3
M15	384	0.294271	0.456309	0	1
M16	384	0.916667	0.276746	0	1

3. Empirical Research

3.1. Willingness to Pay for Hinterland Ecosystem Services Provision

The results of contingent valuation survey show the majority of the respondents 352 (91.7%) residents had a positive WTP, while 32 (8.3%) did not as presented in table 4, shows that the vast majority of the urban residents will have a positive WTP for conserving distant ecosystem services.

Table 4. *Frequency of Willingness to pay for distant ecosystem services.*

WTP	Sample size	Proportion
Yes	352	91.7%
No	32	8.3

Numerous reasons are motivating for the willingness to pay for ecosystem services for Mekelle city residents, which to some extent makes the urban residents faced water ecosystem services scarcity, for better watershed ecosystem services improvements and for continue producing other ecosystem services such as biodiversity conservation, recreation, food and for future generations to use. However, the residents who do not have the willingness to pay mentioned that they cannot afford to pay any additional amount and replied that it should be the government to finance the watershed management activities and consider as it is not their responsibility to pay for watershed conservation and believe the current tariff could improve the water shade management and they not believe that improved watershed management will result in more reliable ecosystem service provision.

In order to make Mekelle city residents' WTP clearer, the author converted birr currency into US dollars by the exchange (US Dollars to Ethiopian Birr exchange rate for September 30, 2019, was 1 USD- 29.4835 ETB.

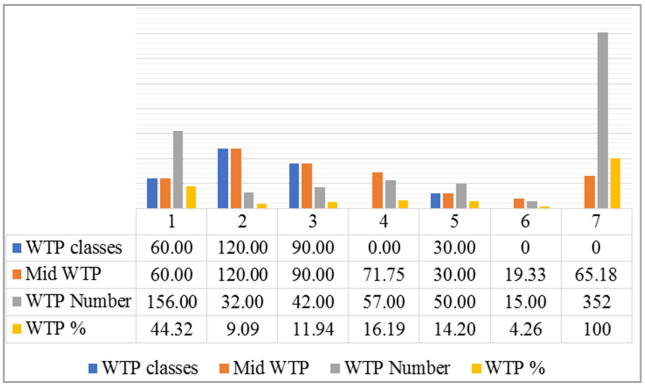


Figure 4. *WTP of Mekelle city Urban residents for hinterland ecosystem services (in ETB).*

The research finding in the above table indicate average household for the ecological protection for hinterland ecosystem services is 65.18 ETB which is $2.21 USD per month.

3.2. Results of the Regressions

Using the Stata version 14 software platform, Heckman's two-stage model was used to study the factors affecting respondents WTP on hinterland ecosystem services. According to the data in Table 5, shows the value of the Wald 19.76 and the P -value is 0.000, indicating the whole model is effective.

Table 5. *Model validity analysis.*

Observations	Restricted Observations	Unrestricted Observations	Wald	P > |z|
384	32	352	19.76	0.000

3.3. Factors Influencing the Urban Residents' WTP

Table 6. *Heckman's first-stage model (Probit model/selection model) estimation results.*

Variables	Coef.	Std. Err.	Z	P>z
M1	0.00611	0.009019	0.68	0.498
M2	0.105797	0.207476	0.51	0.61
M3	-1.28617	0.72091	-1.78	0.074
M4	-1.02644	0.66109	-1.55	0.121
M5	-1.18449	0.744743	-1.59	0.112
M6	-1.05218	0.732628	-1.44	0.151
M7	-0.8596	0.732171	-1.17	0.24

Variables	Coef.	Std. Err.	Z	P>z
M8	-0.8306	0.769112	-1.08	0.28
M9	0.13128	0.216182	0.61	0.544
M10	0.00013	6.15E-05	2.11	0.035
M11	0.037423	0.056498	0.66	0.508
M12	0.310312	0.249775	1.24	0.214
M13	0.472048	0.300103	1.57	0.116
M14	-0.55689	0.278418	-2	0.045
M15	0.035336	0.222612	0.16	0.874
_cons	1.093035	0.88523	1.23	0.217

The empirical results indicated in table 6 reveal that the number of years of stay in Mekelle city (M1) has a positive and statistically significant effect on WTP. In particular, the results suggest that when the household's years of stay in the city are increased by one year, the probability of saying WTP increases. This is perhaps because households who stayed for long years are more aware of the severity of the water supply problem and other ecosystem services types and thus are willing to pay.

The variable sex of the respondent has a positive sign of coefficient suggesting that male respondents are willing to pay more than female. The result is statistically significant and hence the variable can be considered statistically important. The results from M3 up to M8 the sign of coefficients was negative. This suggests that WTP in the study area is not related to education.

The family size (M11) result showed that the variable has a positive sign coefficient which is statistically significant. There is a positive relationship between WTP and the increases in family size of respondent. The higher family size showed in this study higher demand for ecosystem services particularly water supply, recreational activities, etc. The sign of the coefficient for the occupation of respondents (M9) is positive and statistically significant. The sampled respondent who has regular earnings and who receive a salary or paid monthly or weekly are more willing than the unemployed, daily labourer, retired and housewives. The result suggests, regular income earners respondents are more willing for improved watershed ecosystem service than the irregular income earners households such as unemployed, daily labourers, housewives.

The correlation coefficient for an income of the household (M10) is positive, suggests that an increase in the income of the household increases the probability of WTP.

The correlation coefficient of ecosystem services value recognition (M15) i.e awareness shows that positive sign and suggests respondents who are aware of the dependence that urban populations have on local and distant ecosystem services are more willing to pay for improved watershed ecosystem services. Respondents' current satisfaction with the existing watershed ecosystem service has a negative sign of the coefficient. Water utilities and environmental fees have a positive sign of coefficient suggest that despite the high fee's households are willing to pay for improved watershed ecosystem services.

Water quality (M14) used by households have a negative sign coefficient. The Water quantity (M12) and Water reliability (M13) have a positive sign coefficient. This suggests that if households get a more reliable and enough water amount from the major source watersheds ES, they are more likely to pay.

3.4. Factors Influencing the Residents' Payout Level

The Heckman's second-stage model (OLS model) results showed in table 7 show that the M1 (Years of stay in Mekelle city), M2 (sex), M9 (Occupation), M10 (Monthly income of your household), M11 (Family size), M12 (Water quantity), M13 (Water reliability) and M15 (Ecosystem services value recognition) are significantly related to the residents' payout level, while the Education level (M3-M8), M14 (Water quality) does not show statistical significance.

Table 7. *Heckman's second-stage model (OLS model) results.*

Variables	Coef.	Std. Err.	Z	P>/Z/
M1	0.000614	0.001299	0.47	0.000
M2	0.016454	0.029942	0.55	0.000
M3	-0.17273	0.099336	-1.74	0.083
M4	-0.14417	0.100385	-1.44	0.152
M5	-0.15894	0.103264	-1.54	0.125
M6	-0.14039	0.101579	-1.38	0.168
M7	-0.10895	0.100435	-1.08	0.279
M8	-0.10517	0.10372	-1.01	0.311
M9	0.017812	0.032341	0.55	0.000
M10	1.39E-05	7.30E-06	1.91	0.000
M11	0.004289	0.008122	0.53	0.000
M12	0.042929	0.040077	1.07	0.000
M13	0.06115	0.042729	1.43	0.000
M14	-0.07302	0.038323	-1.91	0.058
M15	1.830	0.291	6.290	0.000
_cons	0.876687	0.125101	7.01	0.021
Λ	3.520	0.506	5.790	0.000
Rho	0.721			
Sigma	4.514			

From the above variables who had significant positive correlation with the residents' payout level, means that with the residents who have a positive willingness to pay will have a higher payout level. It may be that the perception and sensitivity to the ecological environment of the residents, which makes them willing to pay a higher payout level. In contrary, variables who are in significant and had negative correlation revealed that the residents had low payout level. Therefore, the above result assures the need of using the Heckman's two-step model.

4. Discussion

Hinterland ecosystems have vital importance to human beings. In recent years, many researchers have done studies on the beneficiarys' willingness to pay to watershed protection by using the contingent valuation method [11]. The article aimed to study hinterland ecosystem services supply for urban residents using Heckmans two stage model for contingent valuation study in Mekelle city. Mekelle city one of the fastest-growing urban areas in Ethiopia has been experiencing serious water shortages partly to the reduced water inflows from the upper catchments of the urban centre and its hinterland that are major suppliers of its water

supplies. Hence, it is very central to evaluate whether upstream communities and beneficiaries of ecosystem services are willing to participate in watershed protection schemes.

The household survey was intended to gather the important data for the WTP investigation. The results proved CVM has a significant role in environmental conservation. The household survey was figured out how much people would be willing to pay for the upstream land conservation. The survey results exposed that the respondents were willing to pay a positive amount for improved hinterland ecosystem services.

This data shows that majority surveyed households were willing to pay for the improved watershed ecosystem service. This type of CVM method can help to raise awareness that city residents are dependent on ecosystem services beyond the city boundary. City residents are not aware of the dependence that urban populations have on local and distant ecosystems. Those who responded that they are aware of the upstream watersheds that can affect household's water quality and quantity and other ecosystem services explain they reason out that proper management of watersheds leads to good water management, links upstream land users and downstream water users economically and socially, It minimizes floods during the rainy season, It improves water quality, Provides more sustainable water supply, improve user's income, absorbs water and make this available for future use and creating job opportunities for peoples living around the watersheds. In addition to this, the respondents also indicated the negative impact of upstream watershed management activity has an impact on downstream users of Mekelle city residents that can have an impact on bundles of ecosystem services.

Despite the fact that households pay a high amount for water bills, the result of the WTP was promising. This shows households were willing to pay to ensure sustainable hinterland ecosystem services. The findings indicate that majority of the households were willing to pay additional fees that could sustain the provision of ecosystem services. The WTP findings are promising conservation tactics that can benefit both beneficiaries and upstream ecosystem services suppliers.

This result showed that integrating demand for ecosystem services makes conservation efforts more efficient. This is helpful to internalize negative externality by city residents through the willingness to pay. The ecosystem service framework is a convenient way to foster intervention on behalf of ecosystems by clearly defining what is at stake with ecosystem decline and corresponding protection efforts. Its greatest utility may be in helping more people understand the connections between conservation and quality of life and that addressing and preventing ecosystem service declines is necessary, beneficial, and are cost effective for present and future generations.

Well-managed watersheds offer numerous ecosystem goods and services to urban and rural populations. Mekelle city is highly dependent on watersheds. However, the land use dynamics have significantly contributed to watershed degradation, increasing vulnerabilities to urban water scarcity. Sustainable watershed management balances resource needs amongst multiple users, and also lessens vulnerabilities, and develops coping capacities to deal with potential risks using mitigation actions.

Making the city residents aware of a greater number of ecosystem services may encourage them to support sustainable fund raising. The preferences of respondents varied depending the ecosystem services that were described. Providing respondents with ecosystem service evidence had a measurable effect on their preferences. The findings of the study are in line with the theory that ecosystem service information should encourage people to consider a wider range of benefits that nature provides and this, in turn, may boost watershed management.

This investigation revealed that, despite, awareness problem of the surveyed respondents, the majority are willing to conserve ecosystem services sources of the watershed within the city and outside the city. This shows households are willing to pay for watershed conservation to ensure sustainable ecosystem services provisions. Thus, proposing PES as an alternative source of funds for the conservation of watersheds is necessary for sustainable finance. This will no doubt supplement the cost of the watershed. If the improved system is introduced in addition to addressing the water needs of Mekelle city, the city administration can collect more funds that can be used for hinterland ecosystem services improvements. The possible total revenue of all city residents in USD 289,477.572 per month can be generated.

The stastical analysis shows that the Mekelle city inhabitants have a strong preference for the conservation of ecosystem services, including both preservation and ecological restoration, over the status quo. The findings of this study can be supportive to planners in resource management plans. These findings revealed that ES provided by watersheds is widely not acknowledged, they are not considered as a relevant aspect when interventions on land use are planned.

Therefore, Mekelle city administration can implement the proposed watershed improvement and in addition to solving the current severe water problem and other ecosystem services, it can also increase the total revenue. The result of the WTP was promising. Therefore, recommends PES as additional conservation funds in the area for sustainable forest management and financial sustainability. Thus, proposing PES as an alternative source of funds for the conservation of watersheds is necessary for sustainable finance. This will no doubt supplement the cost of the watershed.

To maintain ecosystem rehabilitation, a mechanism in which all beneficiaries compensate producers of the ecosystem services should be instituted. Ecosystem conservation benefits different local and international consumers through carbon sequestration and biodiversity preservation. PES will have a positive impact on ecosystem service providers leading to better land use and enhanced

ecosystem service [10].

PES can be an innovative funding source to support future urban ecosystem management. Mekelle city continues to grow rapidly. Incentive-based conservation practices in catchments hold the potential to improve conservation activities. Mekelle city residents are dependent on ecosystems and that the existing loss of ecosystem services is harmful to human well-being. Enactment of the watershed as an urban planning tool allows environmental issues to be incorporated properly, serving to overcome a sectoral vision that persist in urban issues of Mekelle city. To understand the watershed as complex adaptive system drainage and its connections as the network can be adopted. Here, it is necessary to understand it as a space composed of a set of physical, biological, social, and political elements which interact with each other across space and time, modifying the entire system.

The watersheds in the study areas can provide several ecosystem services. To improve the majority of the watersheds that provide the municipal water supply and other services for the city of Mekelle. At present there is awareness and to some extent supported by action in the community to rehabilitation of degraded steep terrains using soil conservation measures and planting trees [21]. Giba Reservoir is determined to be the water source of the project [17]. While start-up funding is available for Giba dam from a loan of Exem Bank China, long-term loan payment, funding sources for future monitoring, improving the sources of water from the watersheds for the dam that will be constructed remain uncertain. A new mechanism to promote financial sustainability for watershed improvement is to launch PES system in which Mekelle city residents pay for a portion of the costs.

Effective spatial planning based on scientific analysis for urban development and their rural surroundings is crucial to attain and ensure a sustainable environment. The basic justification for this argument depends on; rural areas in the study area are sources of numerous ecosystem services.

Previous study applied different models. But this study is different from previous. investigations. Methodological developments associated with Heckman two stage model is rapidly growing. The model applied by this study is useful for current understanding of urban residents' perceptions on ecosystem services supply. A study by [12] explored the public awareness, attitude and perception regarding environmental and water resource issues and assessed the WTP using rankings, Likert scales and random parameter logit gnis (RPL) models.

Moreover, [2, 25] had employed CVM to explore residents' WTP for both upstream and downstream watershed ecosystem services conservations in different countries. They found that beneficiaries are willing to pay a higher amount ecosystem service if they can obtain sustainable provisions of ecosystem services. Methodologically, those studies utilized different types of models such as Tobit model, Structural equation model was employed to inquire into the factors affecting the willingness to pay and the results show that residents' individual heterogeneity were significantly related to the residents' willingness to pay.

However, the disadvantage of the models used in the previous studies is that the factors affecting the residents' WTP cannot be examined concurrently. Particularly, the models could not eliminate the interference of WTP = 0 samples while analyzing the influencing factors of the residents' WTP. It is acceptable that Heckman's two-stage model is capable of solving the above problems and avoiding the sample selection bias. This article analyzes the WTP the urban residents. The Heckman's two-stage model adopted to study the affecting factors of the residents' WTP. The author is optimistic that this research can provide important value for formulating eco-compensation policies for the Giba river basin and the application of PES policies for river basin areas in Ethiopia and other developing countries.

Thus, this study calls social-ecological research that particularly focuses on the relation between ES and human activities, across spatial and temporal of this complex relation. A specific management strategy applied at a local level could impact distant ecosystems and this should be taken into account when developing integrated landscape planning. The new urban agenda that was adopted in Quito in 2016 identified the sustainable development of urban areas as the main goal of spatial planning. This goal needs, to adopt ecosystem-based solutions to preserve and enhance the reimbursements from ecosystems, contributing to citizens' well-being.

Therefore, there is a need for an appropriate balance of the urban centre and its hinterland ecosystem service supply and demand to ensure ecosystem services sustainability. The results of this empirical study have vital policy implications that the government of rapidly urbanizing world should intensify its propaganda about the ecological value distant ecosystem services, increase investment in awareness creation, and establish a variety of policies, in order to protect and improve the hinterland ecosystem services.

5. Conclusions and Recommendation

Mekelle city depends on ecosystem services beyond its administrative boundary. Currently, the city faces an unreliable and inadequate supply of water and other ecosystem service types. The study employed a CVM survey and remotely sensed data to study the status of the watershed. The WTP survey was conducted based on a face-to-face interview with 384 sampled households. The household survey was analyzed using STATA MP version 14.0 using both descriptive and Henchman's Two stage model. The stastical model estimation proves the WTP would be a useful approach to developing a sustainable watershed management program.

The results are promising conservation approach, it can benefit both users and upstream communities through improved watershed ES, yet several factors influence city residents WTP. Still, it is obvious, in Mekelle city, that a knowledge and awareness gap originate from a lack of

sustainable watershed management in the urban center and its hinterland. Government intervention would be necessary to improve awareness and narrow the gap. The WTP survey of the study indicates the government can use these findings to guide the successful implementation of the proposed watershed improvement programs.

Urban centres need to recognize their reliance on the hinterland ecosystems around them as part of the wider watershed, and the impact they have downstream. Depending on the size and scale of the watershed, the municipal or city government may be required to work together with other relevant jurisdictions under some type of watershed planning forum or platform. Therefore, linking upstream and downstream users through WTP and other economic incentives can be important for watershed management sustainability. Sustainable watershed management is crucial for the study area in order to ensure water supplies for drinking, agricultural production, industries, etc. This approach provides an incentive for urban governments to invest in watershed management approaches.

Ecosystem services and resilience thinking have great potential to gather the discontinuous environmental management methods toward sustainable environmental development, but in order for this to happen, the city administration needs to be given the right resources, and incentives, for implementation. To develop a more sustainable city, in Mekelle urban centre and its hinterland new approaches are needed for encouraging and enabling interventions that maintain, improve both urban and peri-urban ecosystems.

In this research, many residents responded that they are not aware of their water sources. and their upstream communities. Environmental awareness on drinking water quality, their sources, and conservation should be improved at the community level. Especially, community-level education on the water reservoir, impact of surface runoff, and nutrient loading can facilitate successful conservation of the water sources and their surrounding open spaces. Community-based actions also can be taken to clean up the land and open space around the water body. Community-based environmental management is environmental planning and management that requires local participation, operated by environmental organizations or institutions. In the process, community-based environmental management aims to reach both environmental goals and socioeconomic goals. In addition to this, people are not very aware of their water sources and other important ecosystem services. Community education and public awareness are necessary to enhance the watershed ecosystem services users' knowledge and understand of the importance and values of watersheds outside city administrative boundaries.

Good practices in watershed management have shown the critical role played by local community groups. in setting priorities and implementing and supporting proposed actions. There is a need to link groups with those in the peri-urban and urban environment to raise awareness of the resource use and sharing elements.

Humans are dependent on ecosystem services for their survival, and the services are influenced by the impacts of climate change. In Ethiopia including the study area, the climate is anticipated to change more than the global average and identified likely changes in ecosystem services and their societal consequences. The effects of climate change in combination with potential anthropogonic drivers may exceed the adaptive capacity of societies. Adapting to ecosystem services dynamics require to give attention of uncertainties and complexities. The results presented provide a basis for future studies exploring ecosystem services demand-supply.

In this regard, the following is suggested (1) Design intervention strategies in order to sustain the provision of watershed ecosystem services through PES schemes (2) Environmental education and community based environmental management (3) Support community and civil society involvement in an integrated watershed and urban planning to build ownership and long-term support (4) Understanding ecosystem service supply, demand, and flows to support climate change adaptation in Mekelle urban centre and its hinterland.

Abbreviations

WTP: Willingness to Pay
USD: United States Dollar
ES: Ecosystem services
CVM: Contingent valuation method
NOAA: The US National Oceanic and Atmospheric Administration
ERDAS: Earth Resources Development Assessment System
GIS: Geographic Information System
ETB: Ethiopian birr
PES: Payment for ecosystem services
LULC: Land use/land cover changes

Consent to Participate

The author needs to accept and confirm the manuscript have read and agreed to its content and are accountable for all aspects of the accuracy and integrity of the manuscript. The article is original, has not already been published in a journal, and is not currently under consideration by another journal.

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Authors' Contributions

The Author (Dr. Shishay kiros weldegebriel) makes sole

contributions to conception and design, and/or acquisition of data, and/or analysis and interpretation of data.

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Conflicts of Interest

The authors declare no competing interests.

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Biography

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