Quantification of Ecosystem Services

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Abstract

Past and present evolution on the consumption of ecosystem services imposed the need to identify quantitative indicators and evaluation methods to highlight the importance of ecosystem services for human well-being. This research identifies and quantifies ecosystem services in a case study, Bic River basin, in the territory of the capital of the Republic of Moldova. The case addresses the practical issue of quantification of ecosystem services, and social and economic valuation. A state of the art on quantification and evaluation of ecosystem services was conducted to show the importance and relationships between these two concepts.

Surveys were developed with different stakeholders to evaluate their perception regarding the ecosystem services. A special attention was given to their awareness and concern for the state of the case study. Also the willingness to pay for the recovering of the river basin was evaluated, and how much they wish to pay. The results show that citizens are ready to pay 1.97 euro/month and students 2.86 euro/month.

This study identifies ecosystem services as playing a fundamental role for the improvement of the individual human well-being measurement indicators. Quantification is a tool to help discover the capacity of the ecosystem to provide services to people. At the same time it was identified that quantification can help to evaluate ecosystem services from social and economic point of view.

In conclusion it was revealed that quantification can be realized through simple quantitative indicators, which represent the present qualitative and quantitative situation of the ecosystem services and help to find solutions for a better management in the future. The indicators that were used are: area that was damaged by floods, quantity of discharged waste waters into the river, and green area per person etc. Social and economic valuation allowed to identify what is the harm made to society and to stakeholders in general. Results show that the present state of ecosystem services is highly affecting the well-being of the citizens, resulting in high costs to recover the damages made to the river ecosystem services, and to replace the services. The value for water regulation service was estimated to be at 159.061 euro. Cost to replace the service of waste water treatment is 32,2 mln euro. Each of the services were quantified and valued based on statistic data found on ecosystem services.

Key words: *ecosystem services, quantification indicators, stakeholder's perception, human well-being, social valuation, economic valuation.*

Resumo

A evolução passada e presente do consumo de serviços do ecossistema impôs a identificação de indicadores de quantificação e métodos de avaliação para destacar a importância destes serviços ecossistêmicos para o bem-estar do ser humano. Essa pesquisa identifica e quantifica os serviços do ecossistema de um caso de estudo, a Bacia do Rio Bic no território da capital da República da Moldávia. O caso integra-nos nos problemas práticos de quantificação dos serviços ambientais e a avaliação social e econômica. Uma moderna quantificação e avaliação de tais serviços foi relacionado para mostrar a importância e as relações entre estes dois conceitos.

Pesquisas foram desenvolvidas com diferentes partes interessadas para avaliar sua percepção sobre os serviços ecossistêmicos. Houve um cuidado especial com a sua ciência e preocupação com o estabelecimento do caso de estudo. Também foi avaliada a disposição de contribuição monetária para a recuperação da bacia hidrográfica pela população bem como o montante a ser contribuído. Obteve-se que os cidadãos estão dispostos a pagar € 1,97 por mês e os estudantes € 2,86 por mês.

Este estudo identifica os serviços dos ecossistemas que desempenham um papel fundamental para a melhoria dos indicadores de medição do bem-estar individual dos humanos. A quantificação é uma ferramenta que permite descobrir a capacidade do ecossistema de fornecer serviços para as pessoas. Também foi identificado que a quantificação pode ajudar a avaliar os serviços dos ecossistemas do ponto de vista social e econômico.

Concluindo, foi revelado que a quantificação pode ser realizada por meio de indicadores de quantificação simples, o que representa a atual situação qualitativa e quantitativa dos serviços dos ecossistemas e ajuda a encontrar soluções para uma melhor gestão dos mesmos no futuro. Os indicadores que foram usados são: área que foi danificada pelas cheias, a quantidade de águas residuais lançadas no rio, a quantidade de carbono sequestrado, a área verde por pessoa, etc. A avaliação social e econômica permitiu identificar qual os danos à sociedade e para os interessados em geral. Os resultados mostram que o estado atual dos serviços dos ecossistemas está a afectar o bem-estar dos cidadãos, resultando em altos custos para recuperar os danos causados ao serviços dos ecossistemas do rio, e para substituir os serviços. O valor para o serviço de regulação da água foi estimada em € 159,061. Custo para substituir o serviço de tratamento de águas residuais é de 32,2 milhões de euros. Cada um dos serviços foram quantificados e valorizados com base em dados estatísticos encontrados sobre os serviços ecossistêmicos.

Palavras-chave: serviços de ecossistemas, indicadores de quantificação, percepção da parte interessada, bem-estar humano, avaliação social e econômica.

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List of Acronyms

ADCM	Avoid Damage Cost Method
CE	Choice Experiment
CV	Contingent Valuation
ES	Ecosystem Services
GDP	Gross Domestic Product
GNH	Gross National Happiness
HDI	Human Development Index
ME	Ministry of Environment
MEA	Millennium Ecosystem Assessment
NCE	National Center for Environment
RBMP	River Basin Management Plan
RP	Revealed Preference
RUM	Random Utility Models
SEA	State Ecological Agency
SP	Stated Preference
TEEB	The Economics of Ecosystems and Biodiversity
TEV	Total Economic Value
UNDP	United Nations Development Program
UNEP	United Nations for Environmental Protection
WTP	Willingness to Pay
WWTP	Waste Water Treatment Plant

1. INTRODUCTION

1.1 Motivation

All economic products results from the transformation of raw materials provided by nature. All human-made products eventually break down, wear out and fall apart, returning to the ecosystem as wastes (Georgescu-Roegen 1971). The extraction of raw materials from nature and the return of disordered waste are known as throughput (Daly 1977).But while the stock of natural resources is depleted at a rate that ecosystems can't afford, they are becoming less and less, leading to disappearance. The lack of these products is affecting human well-being. Fossil fuels resources constitute more than 90 % of the resources consumed for economic production, creating steady flows of carbon dioxide and other pollutants into the atmosphere (Farley 2012). Ecosystem needs time to adapt to each of the changes, resources extraction, and waste inputs.

In the book written by Jared Diamond "The Collapse" most of the reasons why societies were failing to succeed were, increase in population, excessive consumption of the resources (because of their strange behaviors, and traditions), but also because of the internal politics that they had regarding local resources, relations with nature, and relations with other nations. Behind many armed conflicts are staying environmental problems or bad administration of the ecosystem resources, one of the examples can be the genocide happened in Rwanda, because of the bad land distribution, that lead to insufficiency of food, social inequalities, than to a massive killing between local inhabitants.

Technology development made available a higher level of consumption, and economic growth. People are able to extract and produce all the products faster and easier, but the process of the degradation of the ecosystems is also faster. Ehrlich and Ehrlich was describing our negative impact in the following equation I = PAT, where P is the size of the population, A is the consumption per individual and T is the technology that drives the consumption. The product of P, A, and T is impact (I), a rough estimate of how much humanity is degrading the ecosystem services it depends upon. Two billion people, all else being equal, put more greenhouse gases into the atmosphere than one billion. Two billion rich people disrupt the climate more than two billion poor people. Three hundred million Americans consume more petroleum than 1.3 billion Chinese (Yale School of Forestry and Environmental Studies 2008).

The reason why all this problems appeared is that services flowing from natural ecosystems are undervalued by society. The economical growth has been seen for many years as a solution to all the problems related to the well-being of the humanity. The ignorance of these values influences the excessive utilization of these services, leading to degradation.

Few people are conscious of the role natural ecosystem play in generating goods that are traded in the marketplace. As a result, this lack of awareness helps drive the conversion of natural ecosystems to human-dominated systems (agricultural fields, use of lands with fertile soils for industrial places). Because of lack of awareness is hard to quantify the value of the ecosystem services (Daily and Ehrlich 1997). The

ways people relate to their environment are recognized as relevant to ecosystem sustainable management efforts and policies (Flint 2013).

The present research is presenting the state of art of the quantification of ecosystem services, highlighting the contribution of ecosystem services to human well-being and its relation with economics. A case study will be described and evaluated from social and economical point of view in order to reach the goal of the research.

1.2 Research questions and Objectives

Objectives:

- Review of the state of the art in relation to valuation methods for quantifying ES and find out what are most common units of quantification;

- Apply valuation methods to estimate the value of the ecosystem services for a specific case study in order to give more importance to ES, characterization of the case study, identification of ecosystem services, affected ecosystems by the stakeholders and the ecosystems services that are affecting them;

Research questions/hypothesis:

- Is quantification of ES possible?
- Have stakeholders a perception of the value of ecosystem services?
- Is GDP the unit to value human well-being?
- Is human well-being dependent of ecosystem services?

1.3 Research methodology

In most of the cases quantification of the ecosystem services is complicated because of the lack of the statistical data on ecosystems. To achieve the goals that were proposed several methods were used, first the literature review analyses was developed to reveal the importance of the ecosystem services for human well-being and to highlight the quantification and evaluation methods of ecosystem services.

Than a case study was chosen, the Bac River basin in Republic of Moldova, in the area of Chisinau city. The ecosystem services were identified, together with the drivers that are influencing them. The changes made by stakeholders are resulting with providing to them some benefits from ecosystems and also provoking damages to ecosystem services. Identification of the connections with stakeholders those, that are dependent on ES from the river basin. In order to identify better the characteristics of the ecosystem services it was developed first of all a survey to highlight several details. Specifically who affects ecosystem services, who is benefiting, location of vulnerable points of ecosystem. Because in a study about ecosystem services, due to its transdisciplinary nature, requires generating knowledge not only about the ecosystem that generates the benefits, but also about the human societies that receive them. But the amount and type of social information will depend of the purpose of the study. If the scope is to

contribute to the global estimates of services valuation, then the amount of social information required is minimal. Nevertheless the studies oriented to the integration of science and policy or approaches to governance and conservation information on society and socio-ecological interdependencies is necessary (Delgado 2013). After interviews analysis, and accumulation of the needed information, was developed the quantification and evaluation approach of ecosystem services.

2. QUANTIFICATION OF ECOSYSTEM SERVICES: THE STATE OF ART

2.1 Historical context and concepts

"If the bee disappeared off the surface of the globe than man would only have four years of life left, no more bees, no more pollination, no more plants, no more animals, no more man."

Albert Einstein

The late 20th and early 21st centuries have witnessed the emergence of the environment as a political and social issue. The expanded interest in global warming and related environmental concerns have led government and civil society to increase their efforts to raise public understanding of the ecosystem components, water, air and ground pollution (Anderson 2006). An ecosystem is a dynamic complex of plant, animal and microorganism communities and the nonliving environment interacting as a functional unit. Natural ecosystems provide a range of services such as clean water, biodiversity, carbon sequestration and recreational opportunities (Adhikari 2013).

The first mention about the ecosystem services is updated from Plato who acknowledges that deforestation can lead to soil erosion and the drying of springs. Pliny the Elder in the first AD, reported the links between deforestation, rainfall, and the occurrence of torrents. The next who notes about ES is George Perkins Marsh in 1864, is pointing the changes in soil fertility in Mediterranean region that challenged the idea that the Earth's natural resources are unbounded (Baveye 2013).

The modern concept of ecosystem services has progressed significantly in recent decades. Conceived of primarily as a communication tool in the late 1970s to explain societal dependence on nature, it now incorporates economic dimensions and provides help to decision makers for implementing effective conservation policies which support human wellbeing and sustainable development (de Groot 2010).

The first publication to use the term ecosystem services was written in 1981 by Ehrlich and Ehrlich entitled *Extinction: The causes and consequences of the disappearance of species.* In 1987 the Brundtland Report from United Nations pays attention to the importance of the ecosystem services (ES), and the value of natural capital for society. They've highlighted like first priority to establish the problem of disappearing species, threatened ecosystems on political agenda as a major economic and resource issue (World Commision on Environment and Development 1987). Meaning that services provided by them were becoming scarce, and their importance was recognized. UNEP's Millennium Ecosystem Assessment (MA), published in 2005, marked a major milestone in the historical development of the ecosystem services concept. It sought a strong scientific understanding for how ecosystems affect human welfare and how they can be sustainably managed (de Groot 2010). The proof that the exhaustion of the ecosystem services has negative effect on human well-being leading even to the collapse of the whole civilization is related in the book written by Diamond J."*The Collapse: How societies choose to fail or succeed".*

Ecosystem goods and services are, by definition, inherently public in nature, containing all the conditions and processes through which natural ecosystems and the species that make them up, sustain and fulfill human life (Daily C. 1997). Ecosystem goods and services provide benefits to society as a whole, over and above the benefits they provide to individuals (Wilson 2002).

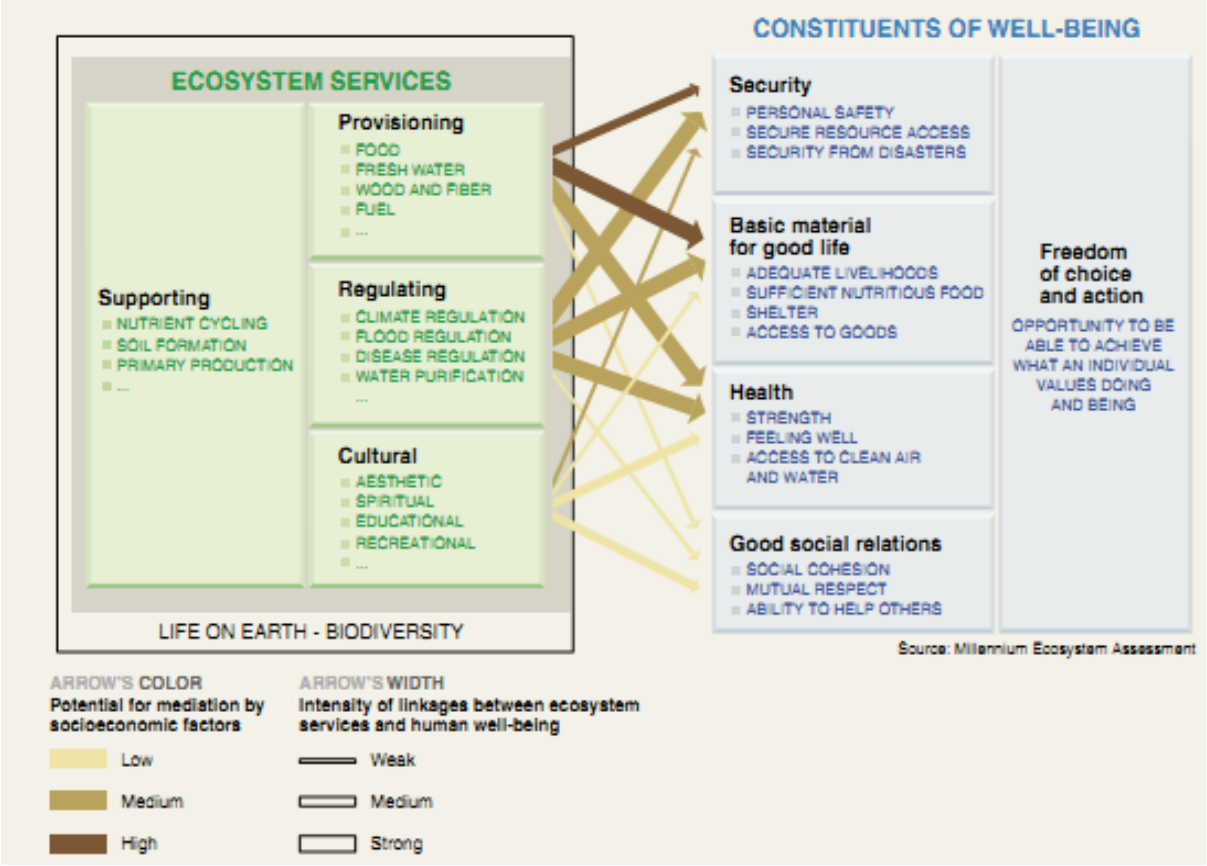


Figure 1 Ecosystem services classification and the strength of linkages between different types of services and constituents of human well-being (Millennium Ecosystem Assessment, 2005)

The above figure depicts the strength of linkages between categories of ecosystem services and components of human well-being that are commonly encountered, and includes indications of the extent to which it is possible for socio-economic factors to mediate the linkage, from Millennium Ecosystem Assessment (2005). Changes in these services can affect humans in various ways. The demand for ecosystem services are now so great that trade-offs among services has become the rule. A country can increase food supply by converting a forest to agriculture, for example, but in so doing it decrease the supply of services that may be equal or greater importance, such as clean water, timber, ecotourism destinations or food regulation and drought control (Millennium Ecosystem Assessment 2003). As so they contribute to human welfare both directly or indirectly, and therefore represent part of the total economic value of the planet. Many developing countries continue to see widespread habitat destruction and declines in biological diversity. The resulting loss of ecosystem services often has significant social and

economic costs. Yet these losses are usually overlooked because most of these services, such as soil retention or spiritual values, are public goods and services. They defy capture in markets, escape pricing, and remain unrelated in the accounts of society. In a business-as-usual scenario, with deforestation continuing at present rates, global human welfare losses have been recently estimated at between $2 trillion and $4.5 trillion of natural capital lost each year. This is a conservative projection, as not all ecosystem services were included in the calculation (Sukhdev 2011).

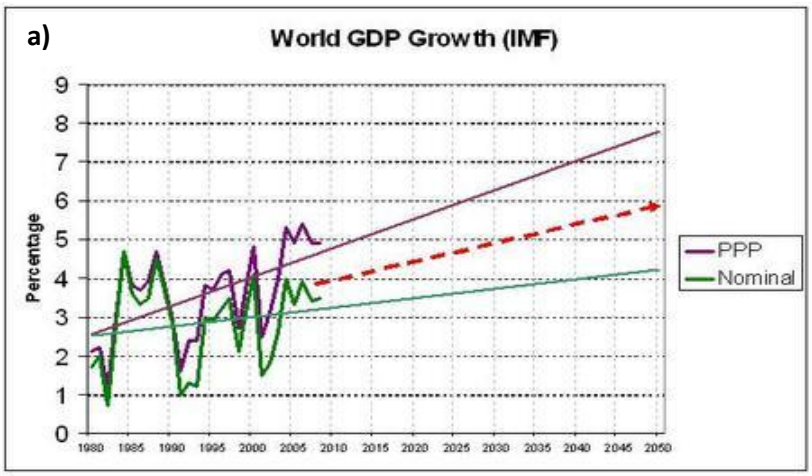
2.1.1 Contribution to human well-being and GDP

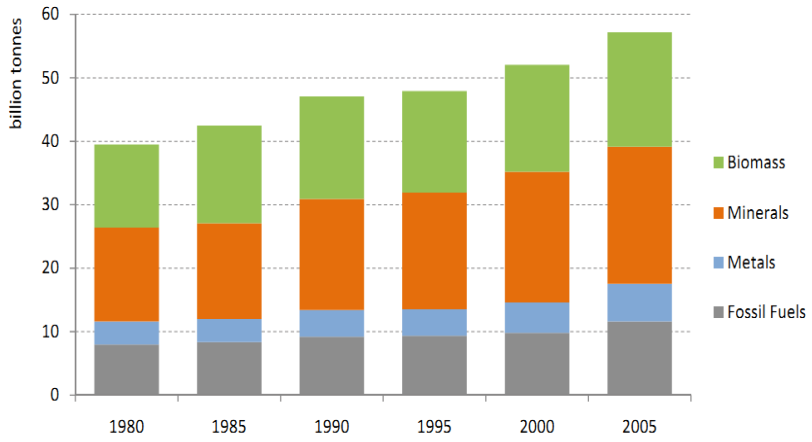
There is a lot of discussion going on, how ecosystem services can influence the well-being of the society together with the problems that the world is facing now. How can human well-being be measured, taking in consideration the contribution of ecosystem services? Going back through the history, in times of Great Depression and World War II, raises the idea of GDP (Gross Domestic Product) the indicator to measure country's economy. It was declared like a tool to measure also human well-being like was specifying Arthur Okun, staff economist for U.S. President John F. Kennedy's Council of Economic Advisers, *"Keep growing the economy and everything will be just fine"* (Dickinson 2011). What GDP represents, is the sum of consumption, government spending, investments, plus the difference between exports and imports (www.simpleclearеasy.com n.d.). GDP ignores wealth variation, international income flows, household production of services, destruction of the environment, and many of the determinants of well-being such as the quality of social relations, economic security and personal safety, health, and longevity , (Anheier 2002), (Fleurbaey 2009), (Michaelson 2009). While the literature suggests that GDP is proven as a successful measure of a country's economic activity, it is widely acknowledged that GDP does not provide an adequate and full assessment of the state of a society because it does not account for the condition and well-being of individuals, families and communities. Moreover, GDP does not include activities outside the market such as caring for people in households, even though without care giving there would be no work force (Leon 2010). Sometimes the choice of some countries to produce a lot in order to obtain more income and also to consider that well-being of their population will be better, is a wrong approach. Economic growth is not a method to measure the welfare of the population. "GDP is precise but not accurate. It is precise because it is replicable; it is inaccurate (as a measure of welfare) because it ignores the contributions of natural capital", says Kubisiewski (2013). Nations need indicators to measure progress towards achieving their goals, which comprise the three pillars of sustainability economical, social and environmental (Kubiszewski 2013), indicators to improve the accuracy of monetary measure of human welfare. But what is the link between GDP, human well being and ecosystem services?

The arguments that GDP current role causes a number of problems in evaluation of the human well-being is true (Kubiszewski 2013), while this indicator is increasing and it will grow (figure 2.2 (a)), due to relative resource consumption.

The fact that many of the natural resources offered by ecosystems are depleted there is no doubt (Daily and Ehrlich 1997). Natural resources, including materials, water, energy and fertile land, are the basis for

our life on Earth. Anyway humanity's rapidly growing consumption of these resources is causing severe damage. From the report made by Sustainable Europe Research Institute, humans today extract and use around 50% more natural resources than only 30 years ago, at about 60 billion tons of raw materials a year. Global annual extraction of natural resources equals the weight of more than 41,000 Empire State Buildings, each weighting around 365,000 tons (or 112 Empire State Buildings every day), (Friends of the Earth 2009).





b)

Figure 2 (a) World GDP growth (singularity2050, 2007) and (b) Global extraction of natural resources 1980 to 2005 (Friends of the Earth, 2009).

These two figures, 2 (a) and 2 (b) shows the relation between the global resource extraction and GDP. While the extraction of resources is increasing, the GDP is also increasing exponentially. As consumption is one of the indicators that form the GDP, from graphs it can be observed that GDP is depending of the consumption of the natural resources. The future projection of GDP is showing an increase till 2050, which means that consumption of the natural resources, will increase even more.

Figure 3 shows the relation between human development index (HDI) and GDP, this indicator goes hand to hand with GDP, but even HDI does not comprise all the particularities of the human well-being. HDI is an indicator which measures the level of human development taking in account such indicators like life expectancy, literacy, educational attainment, and per capita GDP that does not capture all components of well-being (Raudsepp-Hearne 2010).

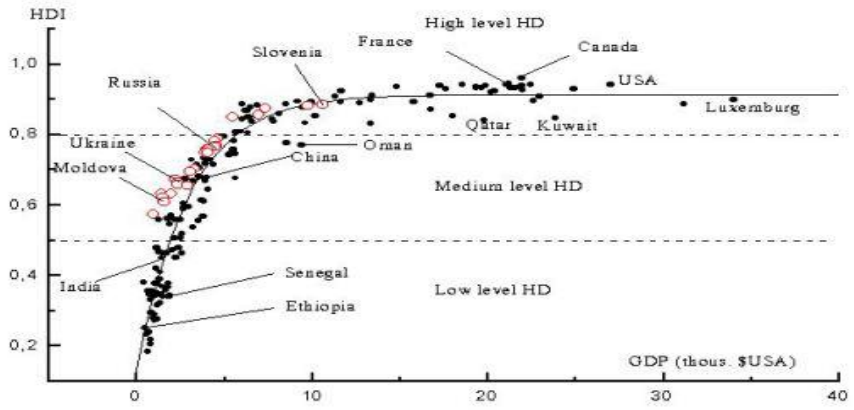


Figure 3 The human development index vs GDP (Keynes, 2012)

In the last years HDI is very often used to express the well-being of the world. As it can be observed from the figure above, many countries have a high HDI and GDP, from the reports on Human Development Index made by UNDP, it can be found out that HDI is growing. But why than appears the question why is human well-being increasing if ecosystems degrade. One explanation is that GDP and HDI do not comprise the indicators of well-being mentioned above.

Another is that the impacts of ecosystem change on well-being are often subtle, which is not to say unimportant; impacts need not to be drastic or to be significant. A small increase in food prices resulting from lower yields as a result of land degradation will affect the well-being of many people, even if none starve as a result (DeFries 2005). The third reason can be that all the resources are exploited at a rate that they can't afford to recover. The fourth is that all the technologies made the extraction even faster, easier to transport, that made them cheaper and underestimated in the market. But also technologies made possible to use this services more rationally. Instead of that, the innovative technologies that exists now can't replace all the ecosystem services, for example aquaculture or a water treatment plant can replace only five services, but not 19 services identified in a seascape of mangroves, coral reefs ad sea grass systems (Moberg and Ronnback 2003).

One example of a good indicator to measure human well-being taking in account the value of natural capital is gross national happiness (GNH). It is the indicator implemented by Bhutan, which aims to

integrate sustainable and equitable economic development across nine domains: psychological well-being, health, education, community vitality, ecological diversity and resilience, time use, good governance, cultural diversity and resilience, and living standards. This 9 domain are weighted using 33 indicators, 2-4 per domain, most reliable have larger weights. The contribution of natural capital in the GNH framework is ultimately its contribution to overall sustainable human well-being as expressed by the nine domains of GNH (Kubiszewskii 2013).

It is difficult to assess the implications of ecosystem changes and to manage ecosystems effectively because many of the effects are slow to become apparent, they may be expressed primarily at some distance from where the ecosystem was changed, and that's why the costs and benefits of changes often accrue to different sets of stakeholders (Millenium Ecosystem Assessment 2005). Concluding to this the drivers of change of ecosystem services are pushed by two broad underlying forces. One is unsustainable growth in the scale of the human enterprise: in population size, in per-capita consumption and also in the environmental impacts technologies and institutions generate as they produce supply those consumables (Ehrlich and Ehrlich 1977). The other underlying driver is the frequent mismatch between short-term, individual economic incentives and long-term, societal well-being. Ecosystem services are generally greatly undervalued, for a number of reasons: many are not traded or valued in marketplace; many serve the public goods rather than provide direct benefits to individual landowners; private property owners often have no way to benefit financially from the ecosystem services supplied to society by their land; economic subsidies often encourage the conversion of such lands to other, market-valued activities. Also society does not compensate landowners and others who do safeguard ecosystem services for the economic benefits they lose by foregoing more effective but destructive land uses. There is a need of valuation techniques that help to include the value of ecosystem services into decision making (Daily and Ehrlich 1997).

Human well-being has a great dependence of ecosystem services, even if humans do not observe that. One concrete example of ecosystem contribution to human well being is one study related by Haq, 2011 that shows that people who were exposed to natural environment, the level of stress decreased rapidly as compared to people who were exposed to urban environment, their stress level remained high. In the same study, patients in an hospital whose rooms were facing a park had a 10% faster recovery and needed 50% less strong relieving medication as compared to patients whose rooms facing a building wall (Haq 2011). The life quality of the people that benefit from the connection with nature is higher, because of the clean air, good view that helps improve mental health. In another research conducted in Swedish cities showed that the more time people spend outdoors in urban green spaces, the less they are affected by stress (Grahn and Stigsdotter 2003). The connection between people and nature is important for everyday enjoyment, work productivity and general mental health (Sorensen 1997). These are only some of the studies that are proving that ecosystem services are contributing to human well-being. But such component of ecosystem like water is providing to humanity annually approximately with 127 million tons

of fish, soil is providing millions of tons of agricultural production (FAO 2013). While man is receiving and depleting the resources provided by ecosystems, increasing the GDP and maintaining his well-being, ecosystems are not receiving anything in return. Meaning that services that are exaggeratedly used by humans will be exhausted and human's well-being will be in danger.

2.2 Valuation of Ecosystem services

The value of a man resides in what he gives and not in what he is capable of receiving.

Albert Einstein

In March 2007, at the meeting of G8+5 Environment Ministers in Potsdam, Germany, it was proposed that a global study on 'the economic significance of the global loss of biological diversity' should be undertaken as part of a 'Potsdam Initiative' for biodiversity. One of the major objectives of this global study, which was entitled, 'The Economics of Ecosystem and Biodiversity' (TEEB), was to assess current approaches for using ecological sciences and economics for informed choices and decision making (Kumar 2013). Also the ecosystem services approach integrates these two disciplines (Ecology and Economics) to help explain the effects of human policies and impacts both on ecosystem function and on human welfare (Farber 2006).

We do not pay for or trade most of the services provided by the natural environment, so they are not captured by GDP or other conventional economic indicators. Nonetheless, natural resources make important contributions to long-term economic performance, and they should be considered economic assets (Sukhdev 2011). An asset is a store of value representing a benefit or series of benefits accruing to the economic owner. Economic benefits reflect a gain or positive utility arising from economic activity (production, consumption, accumulation) (Eigenraam 2011). At first sight a faire trade is the process by which two people change one good for another, and they share benefits. The value of the products that people are receiving from ecosystems is often underestimated or totally excluded; sometime people are taking these products for free.

There are four reasons to value ecosystem services (Beukering 2008):

- "Advocacy: economic valuation is often used to advocate the economic importance of ecosystem services, with ultimate purpose of the ecosystem services, with the ultimate purpose of encouraging sustainable development. For example by demonstrating that the economic values of threatened ecosystem services have previously been underestimated, it can argued that the ecosystem should receive more attention in public policy.
- Decision making: valuation can assist the government to allocate scarce resources to achieve economic, environmental and social goals. Decision makers constantly operate within restricted time frames, their windows of opportunity are limited by the election cycle and they often have to take

decisions in situations where not all the information is available. Economic valuation studies are critical to assist decision makers in making fair and transparent decisions.

- Damage assessment: valuation is increasingly used as a means of assessing damage inflicted on an ecosystem. Damage assessment has been used in many cases to assess the compensation owed after oil spills by large ships and after accidents in mining companies that lead to tailings dam leakages or other toxic waste spills.
- Sustainable financing: valuation of ecosystem services can be used to set taxes or charges for the use of those goods and services. Setting taxes or charges, plays a double role in terms of environmental management. They help to control the exploitation environmental resources (i.e. the more a resource costs the less it is used) and simultaneously generate revenue that can be used to set pay for management, protection and restoration. Valuation results can be used to set taxes or charges at the most desirable level".

From Bayram (2012) "Human beings unarguably have tendency to value. They are valuing things around them: their families, works, hobbies, political views, religion and foods they found delicious, etc". The value of ecosystem services can be roughly divided into three types: economical, social and ecological (DeGroot 2002).

2.2.1 Economic value

Present economic valuations highlight two scenarios. In the first it puts humans in the center of the approach, the second one gives more importance to nature showing that it has potential and man should to keep and preserve it from scientific, philosophical and technological point of view (Bayram 2012). Economic valuation is simply a means to reveal how valuable the natural world is to us, like people are valuing themselves and other people, showing the importance of each human. Estimating an economic value for the natural environment begins with an understanding of the many different services that environment can provide and contribution that these services have to the wellbeing of beneficiaries. Often, decisions to support economic development affect the functioning or quality of ecosystems. Although such decisions are intended to enhance development, they can also reduce the supply of ecosystem services that are critical to human well-being and sustainable development. Economic valuation of affected ecosystem services makes that trade-offs explicit and allows the alternatives to be directly compared using the same units (i.e. money). Valuation reveals very clearly to decision makers what will be lost or gained by making a decision (Brander L. 2013). A variety of values examples that can be applied to monetize ecosystem services are related in the following figure 4.

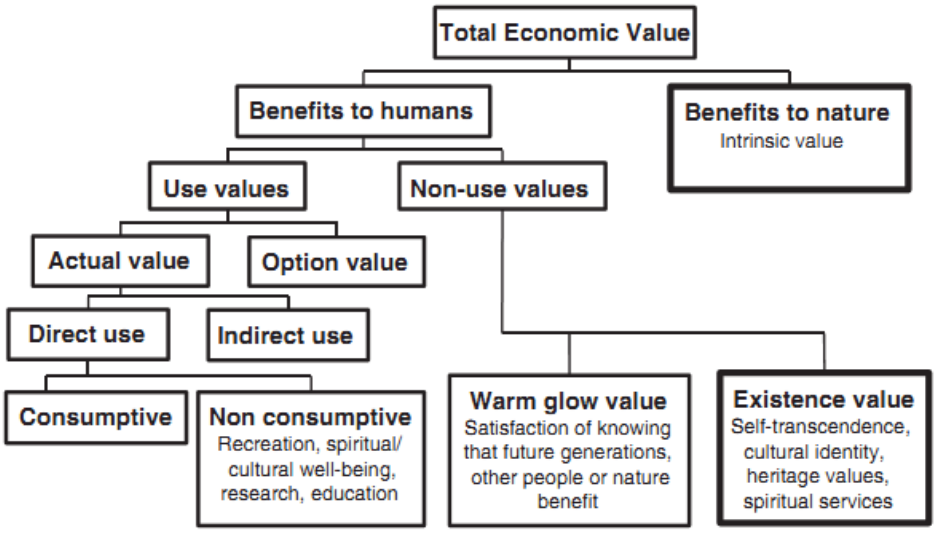


Figure 4 The Total Economic (TEV) Values Typology, (Davidson, 2013).

Total economic value includes the values of both market and non-market goods and services (Raheem 2012). From the figure 4 it can be observed that TEV is divided in benefits from that humans can directly or indirectly benefit and benefits that are received by nature, having a value in itself (intrinsic value). Benefits that are provided to humans are used directly or indirectly by people forming in this way use value and non-use value. Use value includes direct use, indirect use and option value. Specifically:

- Direct use value arises where individuals make direct use of an ecosystem service, whether, by extracting resources from the ecosystem (e.g. food, timber) or from non-consumptive use (e.g. recreation, landscape amenity).
- Indirect use value arises where individuals benefit from ecosystem services supported by a resource rather than directly using it (e.g. climate regulation, water regulation, soil retention, nutrient cycling, pollination etc).
- Option value arises when people place value on having the option to use a resource in the future even if they are not current users. In the context of ecosystem services, option value describes the value placed on maintaining ecosystems and their component species and habitats for possible future uses, some of which may not yet be known (Pittini 2011).

To the non-use value can be attached the following three main components:

- Bequest value arises where individuals attach value from the fact that the ecosystem resource will be passed on to future generations.
- Altruistic value arises where individuals attach values to the availability of the ecosystem resource to others in the current generation.

- Existence value is derived from the existence of an ecosystem resource, even though an individual has no actual or planned use of it. For example, people are willing to pay for the preservation of whales, through donations, even if they know that they may never actually see a whale (Pittini 2011).

The last value of TEV is also and the benefits to nature or intrinsic value. People are valuing themselves like being equal, giving to each other the same importance, even if it's not always the same, but also and nature have importance in itself having the same value as humans life. Elliot (1992), argues that wild nature has *intrinsic value*, which gives rise to obligations to preserve it and to restore it. He relates Moore's theory that says if something have an intrinsic value it ought to exist for its own sake, is good in itself. He is saying about the value of nature in its own value. The reasons of appearing of this concept are the recent environmental problems that forced the searching of new environmental ethics and reconsider the relation with nature (Bayram 2012). From Aldred, (1994) describes that if people who believe in intrinsic value would be strong believers, than they will spend fewer resources to maintain themselves.

2.2.2 Social value

Valuation of ecosystems services is not only about economy of ecosystems, but is about people that value them. Social values and perceptions play an important role in determining the importance of ecosystems, and their functions, to human society (DeGroot 2002). In a report by English Nature (1994), social reasons are mentioned as playing an important role in indentifying important environmental functions, emphasizing physical and mental health, education, cultural diversity and identity, freedom and spiritual values. For example one service that, can be valuable to one person, can't have the same value for another. A study made by Orenstein and Groner, (2014) on the changes in perceptions of ecosystem services across an international border, they are comparing how people are valuing the ecosystem services in Jordan and Israel. Instead of all the similarities they found, there exists and some differences, if Jordanians didn't ranked such aspects of the environment like heat, aridity, dust/sand storms, than Israelis ranked even this processes. But it was depending of the economical development of the country; while Israel is more developed from economical point of view, they have more developed agriculture, more developed technology to take advantage from such environmental factors, but also some of them recognized that their economy is highly depending on ES; than Jordan is weaker at this chapter (Orenstein 2014).

Society attaches a value to ecosystem services. This does not mean values have to be directly expressed in monetary terms. Examples of social values are: number of households depending on a service, number of jobs related to a service, number of people protected against forces of nature (Beukering 2008).

2.3 Economic Valuation methods of Ecosystem Services.

Constanza (1997) was the first who tried to transform ecosystem services in money and to show the approximate value of various ecosystem services in the world, publishing results of a comprehensive study in Nature and estimating the value of annual global ecosystem services at $33 trillion (Constanza 1997). The paper was critically discussed by several researchers; it included the total economic value (TEV) of nature. Anyway author acknowledged about the errors and limitations of the method such as double counting, the exclusion of household labor and the informal economy (Parks 2013). As part of total economic valuation there exists several valuation methods that can be applied to monetize the ecosystem services.

Direct market valuation

Market price approach can sometime provide direct measure of economic value of an ecosystem service. This may be the case for the market price of provisioning services such as the market price for timber or fish (Pittini 2011).

Cost-benefit analysis (Bacal 2007) represents a general direct method of complex estimation of the cost and benefits derived from the realization of ecological projects. It is used for the determination of the total ecologic and economic efficiency of different types of utilization of natural resources from a specific place. Cost-benefit analysis includes direct costs and benefits, regarding the implementation of the projects and external costs and benefits – negative and positive externalities. These are divided in costs and benefits that are forming market prices and shadow prices.

Direct costs include expenditure for the consultancy and designing, implementation of the projects or types of different uses – infrastructure costs, exploitation and maintaining, training of the personal, consultancy.

Costs that form the market prices can include: losses of agricultural, aquaculture and tourism productivity; health costs; costs of prevention of resource depletion and excessive pollution; cost of soil purification; costs of relocation of population and economic and social objects;

Cost that forms shadow prices: chemical, phonic and radioactive pollution; decrease of property value; losses of touristic patrimony and cultural heritage; biodiversity losses.

Direct benefits or financial, that reflects earnings from goods and services sails: resource savings; increase of working places, renovation; improvement of production quality.

Benefit that forms market price: health improvement; increase in agricultural, aquaculture and forestry productivity; increase of income from touristic activities; reduction of treatment cost; reduction of relocation cost.

Benefit that forms shadow prices or indirect benefit: increase in property value; reduction of the air and water pollution level; public services availability; increase in lifestyle quality; improvement of biodiversity (Bacal 2007).

Indirect market valuation

When there are no explicit markets for services, we must resort indirect means of assessing values (DeGroot 2002). For example:

Revealed preference (RP) indirect valuation method, look for related or surrogate markets in which the environmental good is implicitly traded. Information derived from observed behavior in the surrogate markets is used to estimate willingness to pay (WTP), which represents individual's valuation of, or the benefits derived from, the environmental resource. Two such methods are hedonic pricing and travel cost method (Birol 2006).

- Hedonic pricing method is based on Lancaster's characteristics theory of value, which states that any good can be described as a bundle of characteristics and the level these take, and that the price of the good depends on these characteristics and their respective levels. It is commonly applied to variations in housing prices that reflect the value of local environment resources. The price of a house will reflect its relevant characteristics i.e., number of bedrooms, number of bathrooms, size, schools in the neighborhood, level of crime, etc., in addition to the local environmental resources such as ambient air quality, noise level, aesthetic views, water quantity or quality. Some studies show that if the house is closer to the wet area the cost of the house is higher. One of the examples is offered by the Mahan (2000), cited by (Polasky 2012), so decreasing the distance of a house to wet area with 304,8 m (1000 feet), the value of the house is increasing: Lake 1197.79 euro; Wetland 317.83 euro; Stream 188.59 euro. In that way it can be observed the difference, but in that case a wetland has more services to give to the population than the lake and it is undervalued.
- Travel cost methods is used to estimate the use values associated with ecosystems or sites (such as forests, wetlands, parks and beaches) that are used for recreation to which people travel for hunting, fishing, hiking, or watching wildlife. The method can be used to estimate the economic benefits or costs resulting from changes in access costs for a recreational site, elimination of an existing recreational site, addition of a new recreational site and changes in environmental quality at a recreational site (Birol 2006). Other methods that are part of the revealed preference method are:
- Avertive expenditure method - value ecosystem services by looking at the actual expenditure that is undertaken in other contexts to avoid environmental damage which is currently avoided as a result of some ecosystem services being provided. For example the value of pollution control and detoxification services can be assessed by looking at the costs being borne to avoid exposure to similar hazards in other contexts (e.g. costs of meeting health and safety regulations).

- Avoided damage cost method - calculate the costs that are avoided by not allowing the ecosystem to degrade, e.g. flood mitigation value of a wetland area can be estimated by looking at the increase in flood-related costs should that area be drained (Pittini 2011).
- Factor income - estimates changes in producer surplus by subtracting the costs of other inputs in production from the total revenue, and ascribes the remaining surplus as the value of the environmental input (Brander and Florax 2006)
- Replacement cost method - this method values the costs of replacing damaged assets, by assuming these costs are estimates of the benefit flows from avertive behavior. This method assumes that the damage is measurable and that the value of the environmental asset is no greater than the replacement cost (Birol 2006).
- Production function approach – this method can be used to value non-marketed goods and services that serve as an input to the production of the market goods. The approach relates the output of particular marketed goods and services to the inputs necessary to produce them.
- Cost-of-illness method – in which benefits of pollution reduction are measured by estimating the possible savings in direct out-of-pocket expenses resulting from illness (e.g. medicine, doctor and hospitals bills) and opportunity costs (e.g. lost earnings associated with the sickness) (Birol 2006).

Stated preference (SP) methods use carefully structured questionnaires to elicit individuals' preferences for a given change in a natural resource or environmental attribute (Pittini 2011). In addition to their ability to estimate use values of any environmental good, the most important feature of these survey-based methods is that they can estimate the non-use values, enabling estimation of TEV (Birol 2006). From the SP methods there are contingent valuation method and choice experiment method. These two methods attempt to solve the problem of non-use valuation of water by capturing benefits that may be neglected by the other methods (Ojeda 2008).

- Contingent valuation method (CV) is a stated preference method of economic evaluation, which can be applied to public environmental goods that are not traded in markets. CV uses surveys whereby individuals are asked directly about their ex ante monetary values of a change in the provision of a good's quantity or quality. This primarily enables pricing of non-priced public goods, which constitutes a decisive input to cost-benefit analyses of projects. Mitchel and Carson's (1989) opinion is that the advantage of CV is that it does not require the conceptual linkage between market prices and a non-market resources, because the scientist ask directly to the user what will be the value that he is willing to pay for the resource (Mitchell 1989). CV is controversial, generally because it involves asking individuals directly about monetary valuation related to given hypothetical changes in the provision of an amenity, especially when this application of the method also comprises so-called passive-use, or non-use values (Veisten 2007). CV is a democratic process for ensuring that public values are incorporated in policy decisions (Clark 2000). Opinion expressed by Diamond and Hausman, 1994 about the contingent valuation method reveals that there is difference in the willingness to pay through the individuals but also

across the multiple questions and single questions surveys, and many of the survey's respondents are influenced by the actions and they don't really care about the resource. They believe that CV method is a deeply flawed methodology for measuring nonuse values; one does not estimate what its proponents claim to be estimating (Diamond and Hausman 1994).

- Choice experiment method a relatively new addition to the portfolio of SP, the choice experiment method (CE), is theoretically grounded in Lancaster's characteristics theory of value and based on random utility models (RUMs). RUMs are discrete choice econometric models, which assume that the respondent has a perfect discrimination capability whereas the analyst has incomplete information and must therefore take account of uncertainty. A choice experiment is a highly structured method of data generation, relying on carefully designed tasks or "experiments" to reveal the factors that influence choice (Birol 2006). All the methods described above have many advantages but also and disadvantages reported forward in this work (table 1).

Deliberative method of evaluation it can serve like an alternative to self-regarding decision-making process adopted in revealed and stated preference approaches. In deliberation process people know better each other find different solutions; also the decision is more transparent (Parks 2013). From the advantages that deliberative methods have, are:

1. The participants to deliberative process can identify and understand effects and the impacts of different decisions and relative income of each solution.
2. Deliberative valuation recognizes that welfare involves much more than marginal changes in the utility from accumulating market or pseudo-market goods. Deliberative valuation processes explore important dimensions of value than the standard model allows for.
3. The questions are not prepared before the process but during it so it allows to make participants to change their preferences to find common solutions.
4. Also it is important that deliberative valuation can result in more reliable solutions than an individual choice. For example, a study of a group decision-making found that group cohesion and cooperation was a better predictor of a good group performance than average or maximum individual intelligence.

Table 1 Advantages and disadvantages of economic evaluation methods (Birol, 2006).

Method	Advantages	Disadvantages
Hedonic pricing (HP)	Based on observable and readily available data from actual behavior and choices	Difficulty in detecting small effects of environmental quality factors on property prices. Connection between implicit prices and value measures is technically complex and sometimes empirically unobtainable. Ex post valuation (i.e. Conducted after the change in environmental quality or quantity has occurred). Does not measure non-use values.
Travel cost method (TCM)	Based on observable data from actual behavior and choices. Relatively inexpensive. Provides a lower bound willingness to pay (WTP) if certain assumptions are met.	Need for easily observable behavior. Limited to assessment of the current situation. Possible sample selection problems. Ex post valuation. Does not measure non-use values.
Production function method (PFM)	Based on observable data from firms using water as an input. Firmly grounded in macroeconomic theory. Relatively inexpensive.	Understates WTP. Ex post valuation. Does not measure non-use values.
Cost-of-illness method	Relatively inexpensive	Understates WTP because it overlooks averting costs. Limited to assessment of the current situation. Ex post valuation.
Market prices	Based on observable data from actual choices in markets or other negotiated exchanges	Does not provide total values (including non-use values).
Contingent valuation method (CVM)	It can be used to measure the value of anything without need for observable behavior (data). It can measure non-use values. Technique is not generally difficult to understand. Enable ex ante and post valuation.	Subject to various biases (e.g. Interviewing bias, starting point bias, non-response bias, strategic bias, yea-saying bias, insensitivity to scope or embedding bias, payment vehicle bias, information bias, hypothetical bias). Expensive due to the need for thorough survey development and pre-testing. Controversial for non-use value applications.
Choice experiment method (CEM)	It can be used to measure the value of any environmental resource without need for observable behavior (data), as well as the values of their multiple attributes. It can measure non-use values. Eliminates several biases of CVM. Enables ex ante and post valuation.	Technique can be difficult to understand. Expensive due to the need for thorough survey development and pre-testing. Controversial for non-use value applications.

To the last point Wilson and Howarth, 2002 are coming with another opinion the individual and group valuation methods can complement each other. For example small discussion groups were found to yield significantly more ecosystem services than individuals, but individuals appeared to be more comfortable volunteering controversial information during private interviews (Wilson 2002). Deliberative valuation it can serve as method to find out what is the value of a service in monetary terms and also from societal point of view.

2.4 Quantification of ES

From the dictionary quantification is defined as the act of discovering or expressing the quantity of something. The environment is large, changes very slowly, and can be considered as a background or context within which economic dynamics occur (Limburg 2002). Going back to water and diamonds paradox described by Smith (1776), from where it can be observed that if the resource exists from abundance than its value is low, and if the good is scarce, diamonds for example, than people will value it at a much higher price than water, even if it is more important for survival. Changes in ecosystem goods and services appear as a result of intensification of human activities, but as changes are very hard to observe sometime, they are not included in the formation of the value of the resources. Ecosystem services availability vary in time and space, that's why quantification is an important tool to obtain more precise values for goods and services provided by ecosystems. Quantification is important when the scope is to evaluate the ES. Quantified output is essential also for measuring ES trade-offs (Bagstad 2013), Verburg says that "valuation studies can benefit from quantification studies", quantification is recognized to be a way to communicate the importance of ecosystem services (Berkel 2014).

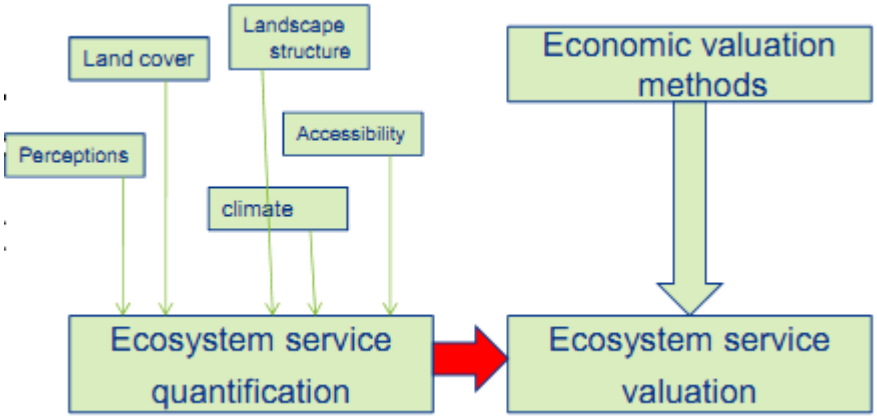


Figure 5 Relation between valuation and quantification (Verburg 2011)

Characterization of the changes and capacities of ecosystem services contributes to the quantification of the ecosystem. The components that can be described to quantify services are landscape cover, landscape structure, climate, perceptions, and accessibility. Then, quantification is helping easier to evaluate the services, using economic valuation methods and social valuation method. Figure 5 shows the dependence of valuation of quantification.

There exists a variety of models that can help the quantification of the services one example is GIS based model called InVest, which is used more often to map ecosystem services and better to show the changes in ecosystem. This model is using a combination of biophysical parameters, for example, annual production data with specific expansion factors per vegetation types and a quantification of soil carbon stocks in order to quantify and map carbon sequestration in different habitats (Lavorel 2012).

The observational and experimental evidences of decline in ES over the last century have contributed to the request for ES quantification, monitoring and valuation (Ghaley 2013). Quantification of environmental values is increasingly demanded by policymakers and agencies responsible for implementing environmental policy. It has significantly contributed to strategic decision-making (Beukering 2008). One of the elements of decision-making process related to ecosystems and their services is to: recognize that not all values at stake can be quantified and thus quantification can provide a false objectivity in decision processes that have significant subjective elements (Millenium Ecosystem Assessment 2005).

Quantification is necessary for several reasons (Chevassus-au-louis 2009):

- When the same human pressure has antagonistic effects. This is the case of the intensification of agriculture, with greater pressure on cultivated land and a potential slowing of deforestation. The qualitative result (the impact on biodiversity) depends on the relative importance of these two effects;
- When there is a choice between different ways of occupying land: urbanization, agriculture, ecotourism etc.;
- In order to facilitate the comparison of the outputs from these models with those from the climatic and/or socio-economic scenarios.

Ecosystem services need good indicators to express the capacity of ecosystem to provide services, or to highlight changes in ecosystem services. Chevassus-au Louis (2009) relates that indicators refer to numerous spatial (of damage to biosphere), time (non comparable genetic species or ecosystem changes) and symbolic (representation) scales. Sometime to implement an indicator is hard because of the limited knowledge, but it should not be used as an excuse to not quantify the ecosystem services. For policy makers is very important to be able to quantify the provision of goods and services, on a before and after, site specific basis to get a true idea of the impact of a development or human activity (Beaumont 2007).

There are a variety of units to measure ES; they are directly linked to the service. Some of them can be quantity of renewable water supply for an aquifer, annual sustainably harvestable fish or timber or fruits in certain area, amount of agricultural produce per hectare, amount of carbon stored per hectare of forest, number of species occurring in certain area etc (Beukering 2008). Ghaley (2013), used to describe this quantification as being biophysical. Further in this chapter will be presented some case studies where quantification and valuation of ES contributed to take the right decisions at all levels of administration.

2.3.1. Case studies to illustrate valuation and quantification

Depending of the case and ecosystem services that people are favoring of, there exist a number of valuations and quantification methods applied. Several studies were developed, from that moment, when ecosystem services became more important to the people and the valuation of ES became a priority for

the decision making. The following case studies serve only as an illustration to show how ecosystem services can be valued and quantified.

One of the first case studies is located in the desert area west of the Nile Delta, where groundwater based export-oriented agriculture has developed. Here the rate of groundwater extraction exceeded the recovering of reserves. To prevent this situation the Government of Egypt has proposed to pump 1,6 billion cubic meters of fresh water from the Rosseta Nile branch into an area of about 45,000 ha. Valuation of ES focused on the services linked to water resources under influence of the major driver of change, i.e. transfer of water from the Nile to the desert area. Valuation was based on financial gains and losses linked to agricultural water supply quantified; other services quantified in terms of numbers of jobs or people affected (Beukering 2008).

Water quality has been valued in many studies. Ribaudo (1989) has made one valuation study on water quality benefits, using averting expenditures methods. He valued the economic benefits from reduction in the discharge of pollutants in waterway systems for nine impact categories: recreational fishing, navigation, water storage, irrigation ditches, water treatment, industrial water use, steam cooling, and flooding. The study area was all the US territory, which was operationalized in terms of ten regions. Benefits were defined in terms of changes in defensive expenditures, changes in production costs, and changes in consumer surplus, depending on the damage category and the availability of data. The total water quality benefits were estimated to be $4,4 billion dollars (Nunes 2001).

An interesting case is brought by Rogosic (2006), on provisioning service livestock production. The research retells about shrubs an important source of forage for sheep and goats. It is served by Maquis and Garrigue ecosystems of Mediterranean zone, which is extensively used by farmers that feed their animals. Shrub cover is useful also for the prevention of soil erosion and desertification. A great impact on disappearance of these species of shrubs have over grazing, infrastructure development from tourism and urbanization, leading to changes in land-use and climate change. The quantification indicators that were used are: presence of shrub species; shrub diversity and density; nutrient value of leaf matter and leaf biomass; live weight gain of grazing animals. Valuation technique: benefit transfer method – quantifying the total amount of production that was obtained from sheep and goats livestock. Direct valuation application of the market value of sheep and goats including consumer and producer surplus.

The research made by Verhoeven et. al 2006 in Sweden is serving like an example of quantification and valuation of the ecosystem services, specifically of improving water quality by nutrient retention. It is a regulating service given by river and floodplains ecosystem. Types of indicators used to quantify the ecosystem service are: number of abundance in species, sensitive vs tolerant species to nutrient input; vegetation density, species composition; capacity to store nutrients, width of marginal wetland zone, growth rate, nutrient uptake; nutrient flux into water body N and P-concentrations. For valuation was used

a replacement cost method, so the total replacement cost of wetlands area in Sweden is 23,5 mln euro/year (Verhoeven 2006).

Another case is the estimation of the economic value of the ecosystem services offered by Danube floodplain forests at a regional scale. Regulatory services that were evaluated were flood reduction, water self-purification, climate regulation. Types of probable indicators to use can be structural diversity and percentage of tree cover. The value of the ecosystem services was the result of the sum between input resource value, the recreational value and the least cost of nutrient reduction that is provided at 374 euro/ha. This still reflects a portion of total economic value of the services (Gren 1995).

The recreational aspects of all urban ecosystem, with possibilities to play and rest, are perhaps the highest valued ecosystem services in cities (Bolund 1999). Society also can participate actively to quantification of the ecosystem services by evaluating what service they need and from what service they are favoring of.

From the cases presented above it can revealed that quantification is an important process before the evaluation of the ecosystem services. Ecosystem can be quantified not only by their biophysical characteristics, by their capacity to serve people, quality and quantity, but also the ability of a regulation service such as water treatment to receive and treat a specific amount of quantity of pollutants.

Quantification and valuation of ES remains an important process for highlighting the significance of ES to people. The use of the specific method or quantification technique depends from case to case and the goal that was set to achieve. But there exists no perfect method to value and to quantify the concrete value of the ecosystem services.

3. METHODS TO DEVELOP THE CASE STUDY

3.1 Survey method

Questionnaires were developed to valuate human perception of the environment and preference method was used (willingness to pay for a certain service). The interviews were developed in the area of river basin with determined groups of stakeholders that are benefiting or affecting the ecosystem services.

The questionnaire for citizens and students consists of 3 parts environmental, social and economical (Annex I). Each of the questions has at least three possible options from which they could chose. Depending of the interest and power of the stakeholder, questions applied were different for each of the stakeholders. The objective of the questionnaires was to evaluate the perception of these stakeholders, to identify what is environmental concern and awareness of different stakeholders and what is the level of importance, that they give to these ecosystems and if people will be willing to pay for a better quality of the river. The questionnaire was developed, based on the researches made previously by the researchers Diekmann (2000) and White (2005), but including also the results obtained by other scientists on contingent evaluation method that includes the evaluation of willingness to pay for a certain ecosystem service.

3.3 Quantification and valuation

Often the value of ecosystem services is out of consideration, and for humans what do not have a value, don't have any importance so it is free. Society would cease to exist in the absence of ecosystem services. Thus, their immense value to humanity is unquestionable. Yet quantifying the value of ES in specific localities is no simple task (Daily and Ehrlich 1997). Previously in this work was said that the study will be focused also on the social and economical valuation. Ecosystem services can be valued in terms of number of people affected in the absence of the certain service, number of jobs lost, and number of economic agents that will suffer losses but lack of concrete data is making this valuation impossible. So far, social valuation will be based on the questionnaires described above. The literature review developed in this study highlights many of the valuation methods of ecosystem services. Economic valuation can be obtained through direct and indirect estimation methods. Direct valuation can be applied to the marketable products or services, whereas the services for which market does not exist are evaluated by indirect valuation methods (Shams Uddin 2013). For this case it will be tried to use avoid damage cost method (ADCM), replacement cost method (RCM), Cost of Illness method and Hedonic Pricing (DeGroot 2002). The evaluation will be done according to the information that will be collected during the study of the case, stakeholder's interviews and also depending of the ecosystem services provided by the river.

4. DATA ANALYSIS AND RESULTS

4.1 The case-study review

Republic of Moldova is situated in the Eastern part of Europe, between Ukraine and Romania, with a very favorable climate and good soil fertility, with an economy based on agriculture. Total number of population is 3 559,5 million inhabitants. With a total annual GDP in 2013 of 3,9 million euro, monthly medium salary of 204,09 euro (National Bureau of Statistics, 2013). Is a country in process of developing, which was declared independent on 27th of august 1991, it signed the association agreement with European Union in 2014, and is starting to work better to improve their economy, but anyway is paying less attention to the importance of environment.

source: Chisinau water supply and sewage treament feasebility study

Figure 6 Map of the Republic of Moldova and Chisinau city location

Chisinau - the capital of Republic of Moldova is located in the central part of the country (figure 6) on Moldavian Central Plateau, in the valley of Bâc River basin. The slopes of the valley are intersected by ravines and gullies. The city represents the political, economical, scientific, educational and cultural center of the country. The physic-geographic position of Chisinau is favorable; it has a continental-moderate climate with short winters and long, hot summers. Annual temperature is between 10,5-11,4 ^{o}C annual average precipitations are between 500-700 mm. The negative aspects of the clime are droughts which in central part of the country can occur 2-3 times in 10 years.

In national context it is an urban strategic center, increasing economical competitiveness and development of national economy. In international context it has a limited international function, with a big deficit of metropolitan services. Comparing the city, from the economical and social point of view with cities from neighbor countries, Iasi (Romania) or Odessa and Lviv (Ukraine), Chisinau has a lower level of development.

The population of the Chisinau from the last data from 2013, is 671.8 thousands inhabitants with 31,544 private households. In last year's the population of the city is increasing and it will keep growing in the near future (figure 7). The ethnical structure of the population that lives in Chisinau is, Moldavians more than 70 %, Russians 15 %, Ukrainians 9 %, Gagauzians, Bulgarians and Polish and other.

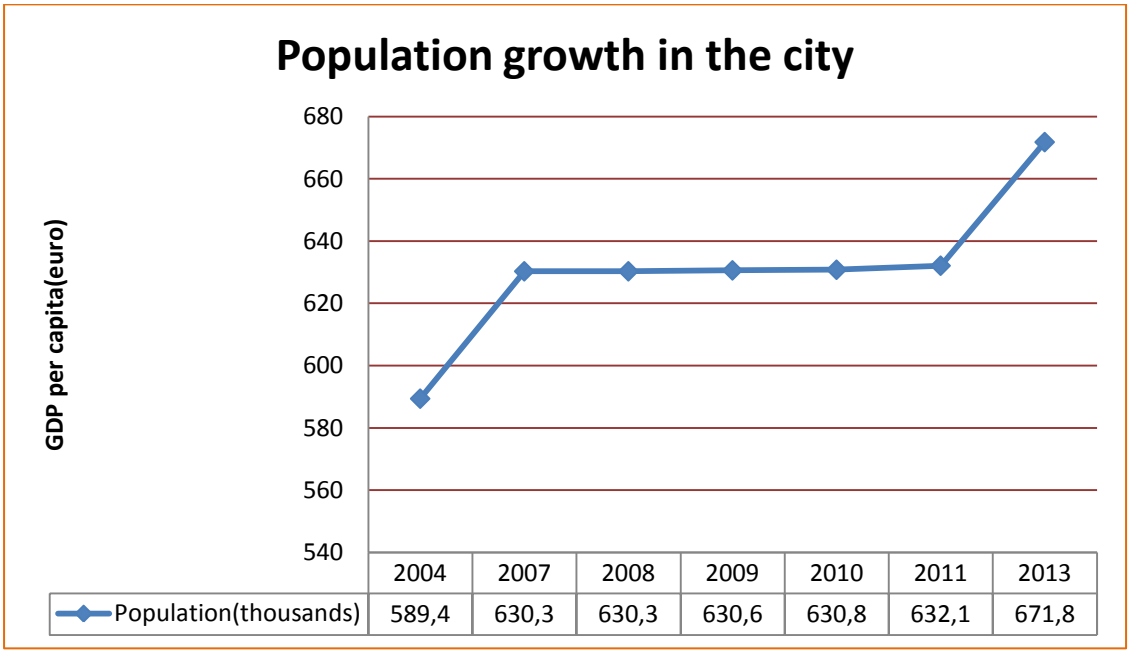


Figure 7 The evolution of the population from 2004 to 2013 in Chisinau (National Bureau of Statistics, 2013).

In Chisinau are registered 85600 economic agents. Economic activities are developed in 30842 enterprises (fig 8). The city provides 45% of the GDP and more than 60% of total volume of taxes earned in state budget, 80% of imports and 60% of exports belong also to Chisinau. From the total number of companies 70% are activating in Chisinau. That shows that Chisinau have a great impact on economic development of the country.

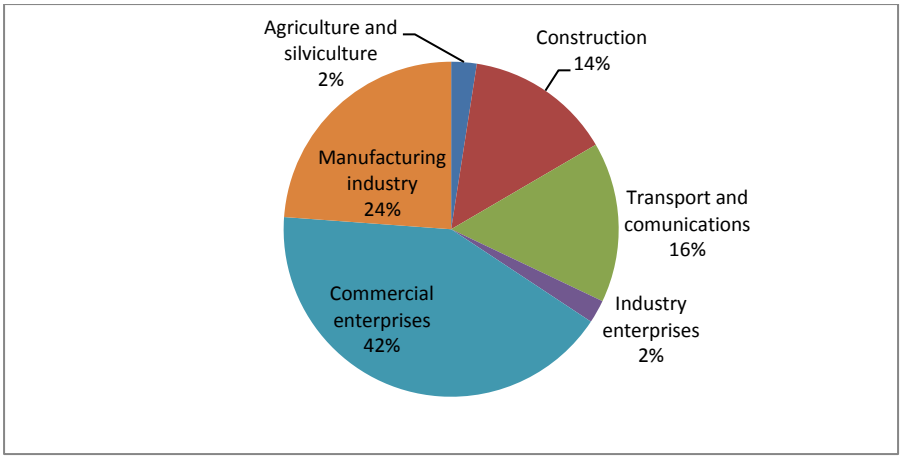


Figure 8 The distribution of economic agents by activities in Chisinau (Mustea, 2013).

The study area includes the territory of the Bâc river basin in the Chisinau city (figure 9). Bac River is located in the centre of Republic of Moldova is one of right sided effluent of Dniester River; the spring is located in Temeleuț village, district Calarasi. It has a length of 155 km. Total surface of the Bac River basin constitutes 2020 km^2 (National Bureau of Statistics 2013). The river is flowing through 4 districts and one municipality. In the city limits Bâc River have a length of 19,5 km.

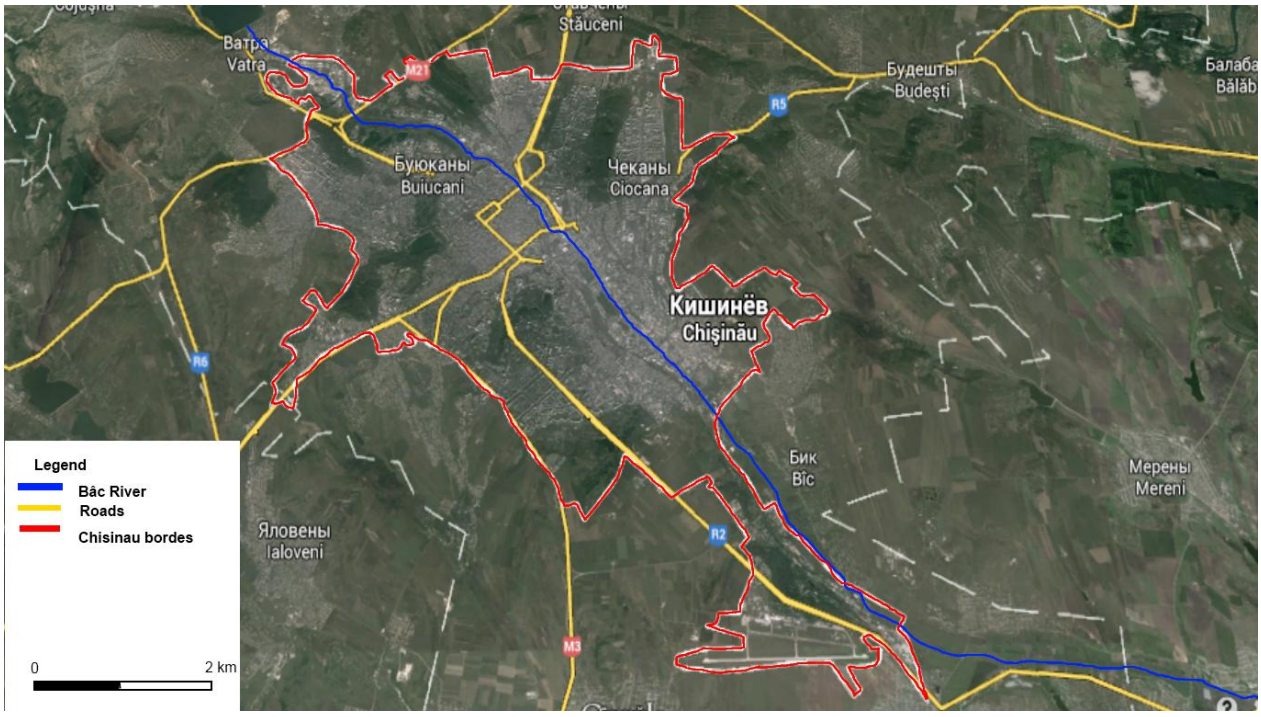


Figure 9 Map of the Chisinau city and Bâc River

The total area of lands of the villages and cities that are included in the river basin from the municipality territory is 31,108 ha 54.14 % from the total area of the Chisinau Municipality (table 3).

Table 2. Land distribution in the Bac river basin, in the municipality of Chisinau (ha), (Mustea, 2013).

Type of land	Surface	
	Ha	%
Agricultural lands	21381	68,73%
Arable	13897	44,67%
Multiannual plantations	5046	16,22%
Pastures	2038	6,55%
Forestry plantations	3706	11,91%
Eroded lands	8457	27,19%
Landslides	80	0,26%
Ravines	36	0,12%

All the area of river basin is situated on two geomorphologic zones, Codrii and Prenistrean Plateau. Because of the city landscape river is the receiver of almost all the pluvial waters from the city and waters discharged by economic agents and Waste Water Treatment Plant (WWTP). Along the river, in the city area, land is used for residential purposes and economic activities private and public, also in some parts riverside is occupied by green space that serves like protection zone. City has an enormous impact on the quality and ecosystem services that are offered to the citizens by it. In the following subchapter are described the ecosystem services and drivers that are influencing their change.

4.2. Ecosystem services identification.

Ecosystems offer to people services and goods, which are not often taken in consideration in the market. From Millennium Ecosystem Assessment there are four types of services provided to the people exerting different functions, provisioning (food, wood for timber, for heating and other purposes etc), regulating (protection from floods, waste treatment, pollination etc.), supporting (supporting of species, of nutrient cycles) and cultural (recreation, leisure, education etc.)

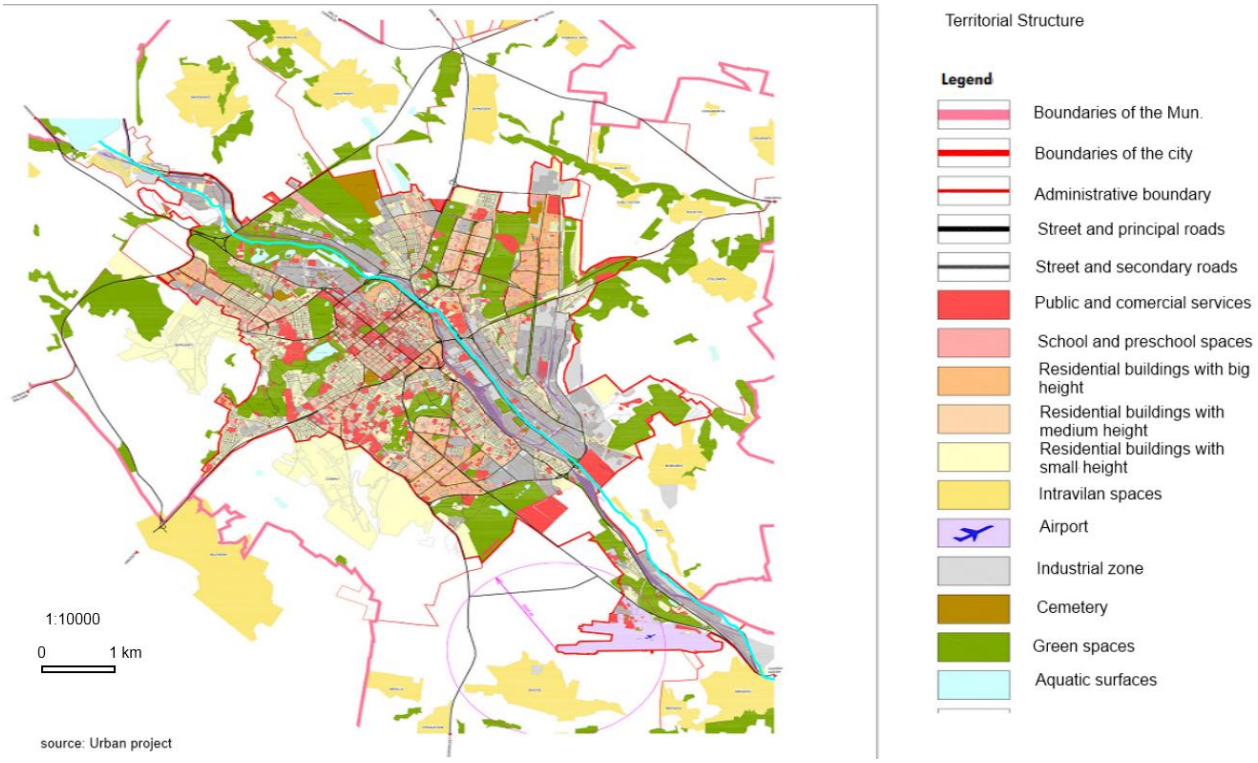


Figure 10 Map of the Chisinau territorial structure, showing Bac river basin land use.

Regulation services

Water regulation

Except provisioning services from which citizens have direct benefits, the regulation services are providing to humans, services, that are not often seen by people like a source of income, such like water regulation service provided by forests and river, that have a role in regulating the runoff flooding control and medium transport for pluvial waters.

Air purification

This service is provided by the most important “lungs” of the planet, forests. The amount of green spaces that constitutes the protection zone of the river, have an important role in sequestration of CO_2 in the city. There are two main sources of air pollution in the city stationary and mobile sources. The main function of the gas regulation function is the maintenance of clean air, sequestration of the carbon.

Climate regulation

The climate regulation is very important at the local level were the air pollution is high. Because combined with increased temperatures it creates the island effect, having a big impact on the population’s health. The green areas from the river basin are playing an important role in climate regulation in the city, because almost all the area of the riverside is occupied by the residential constructions and industry.

Erosion regulation

Republic of Moldova is an agricultural state; soils are the most important source of income for most of the population. Soil erosion became more and more highlighted problem in last decades. In the present almost 50 % of the territories are eroded. In the city of Chisinau the Bic River basin, 8457 ha of the territories are affected by erosion. Vegetation is playing an important role in prevention of the soil erosion, by retention of the water runoff, increasing the level of permeability of the soil, contributing to higher capacity of infiltration of the pluvial water in the soils. Chisinau is affected of such processes as landslides, ravines, and linear erosion, in fact is because of the anthropogenic activity of the human in more part but also because of the relief and geological, and soil structure.

Waste water treatment

One more ecosystem service provided to people for free is waste water treatment. Water from the Bic River is working like a waste water treatment plant diluting the waste water from the almost all municipal activities. Riparian zone of the river is the filter of all runoffs from the city during the precipitations.

Pollination

It is a service that in most of the cases is not observed because it is provided to the people by such little species like bees and other little creatures that play an important role of keeping the life on the planet. They are pollinating the wild plant species and crops. On the territory of the river basin there are zones that are occupied by vegetation, there are also agricultural activities that need and are pollinated.

Supporting services

Species supporting

Bic River basin serves as a good refugee for different species of birds, insects, amphibians, also good habitat for supporting the vegetation. The territory of the river basin supports the buildings in that are living or working citizens of the city. In exchange the soil is losing the permeability in result of giving the support for buildings.

Cultural services

Recreational services

Green areas are perfect places to go for recreation. Also riverside have a great potential to be used for recreation, but nobody uses it more of the people are going in parks and at the improvised lake beaches from the river basin for recreation. In the following table are represented the ecosystem services and the sources from which they are provided.

Table 3 Ecosystem services and service provider

Bâc River basin			
Ecosystem services	**Component of the ecosystem that provides the service**		
	Land	**Vegetation**	**Water**
Regulating			
Water regulation	●	●	
Air purification		●	
Erosion regulation		●	
Pollination*			
Waste water treatment	●	●	●
Climate regulation		●	●
Supporting			
Supporting of species	●	●	●
Cultural			
Recreational service		●	

*Pollination is the only service that is not provided by any of these components; it is provided by bees and other insects.

4.3 Drivers of change

Any social, biophysical or economical intervention, which leads to a change in ecosystem services, can be considered a driver of change they can affect directly or indirectly the service provided to humans (Slootweg 2006). The indirect drivers of change represents the changes more in social factor and economical for example an increase in population will lead to a higher level of product consumption, and with this more exploration of ecosystem services, will be a need in more place to live that can lead to changes in land use. Indirect drivers influence the appearance of direct drivers that are biophysical (changes in land use, species introduction etc.).

Table 4 Drivers of change and associated problems

Drivers		Associated problems
Indirect	Demographic changes	Increase in food consumption
		Changes in land use
		Increase in number of vehicles
	Economic activity	Pollution of air, water and soil
		Climate change
		Consumption of resources
	Climate change	Food losses
		Population health risk
		Water demand
		Biodiversity losses
	Policy	Bad territorial management (privatization)
		Illegal constructions
Direct	Climate variability	Increased temperatures
		Flooded territories
		Damages to public facilities
		Health risks
	Urbanization	Decrease of permeability of the soils
		Island effect
		Biodiversity disturbances
	Insufficient technology and infrastructure	Waste water discharges
		Pollution of water

Indirect drivers

Demographic changes

From indirect drivers of change can be noticed the demographic changes. That can be seen very well in the population pyramid figure, data taken from National Office of Statistics, 2011. Population pyramids can better to show the future projections of the population of a city or of a country. The pyramid shows the structure of the population by gender and age in Chisinau in 2011. By age population can be separated in three categories pre reproductive 0-14; reproductive 15-44 and post reproductive 45 and higher. From the figure 11 can be observed that post reproductive population is lower than reproductive. The population between 15 and 44 years that includes reproductive population is high that means that in next 10 years there will be an increase in population but at very low rate. But it can be observed also that even if pre reproductive population is big, the number of feminine gender is almost twice lower than masculine, meaning that the population will decrease after 10 years.

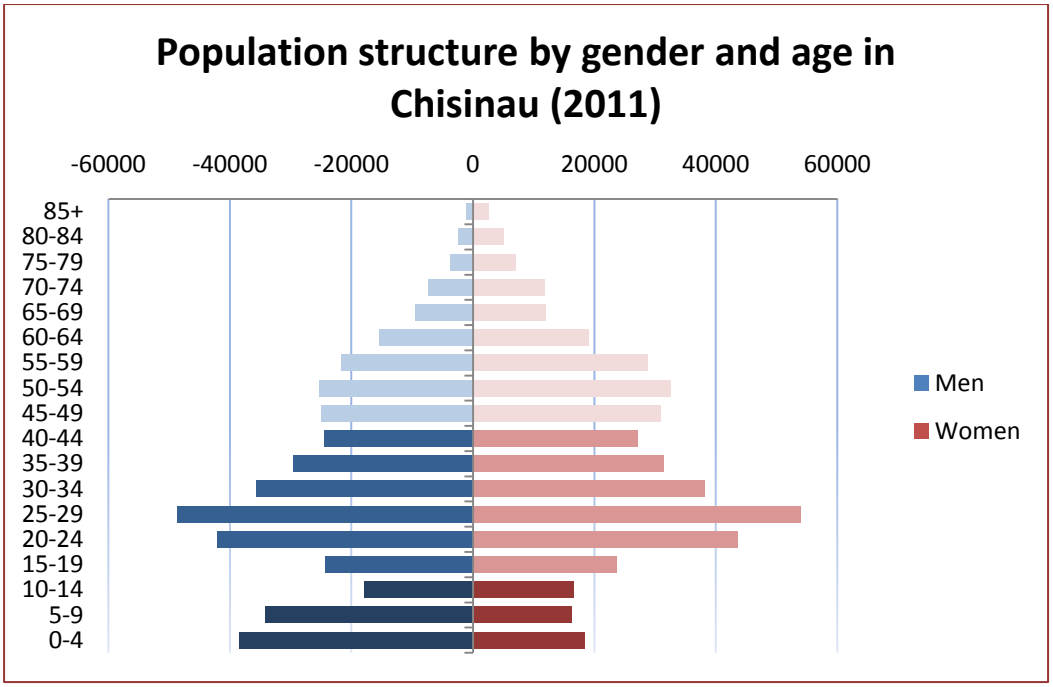


Figure 11 Population structure by gender and age in Chisinau (2011), data from (National Bureau of Statistics, 2011).

Taking in account, the GDP per capita that is increasing, medium salary is also increasing in each year it is expected that population will grow, but examples from other cities are showing that with development many countries are losing in number of population, also because of this reason it is expected that Chisinau will lose population when the city will be at the peak of its development. As an example can serve, countries like Germany, Italy or Spain. These countries are cases were population is in decline, with a rate of fertility of between 1.3-1.4, high rate of old population, life expectancy of 80 years and higher. Last two countries are suffering of economic crisis now; Germany is still having a powerful economy, but specialists are predicting a decline in development for the future because of the population decrease. But not should be avoided and the emigration problem, many of the young people are emigrating in other countries, the reasons is the economic crisis, the results of emigration of young people are high rates of old people, and lack of working force. The evolution of population from a region from Italy, Liguria, which now has a 13 percent of 75 years old population, is expecting to increase to 18 percent in 2030, in Germany, Chemnitz region it will increase from ten to 19 percent of 75 years old people (Hobmann 2008).

Economical development

Changes in demographics have an effect on economical development, because it influences the consumption and production, results increase in economical development, population growth influences the energy consumption, water consumption. More population needs more houses to live, so level of urbanization will grow.

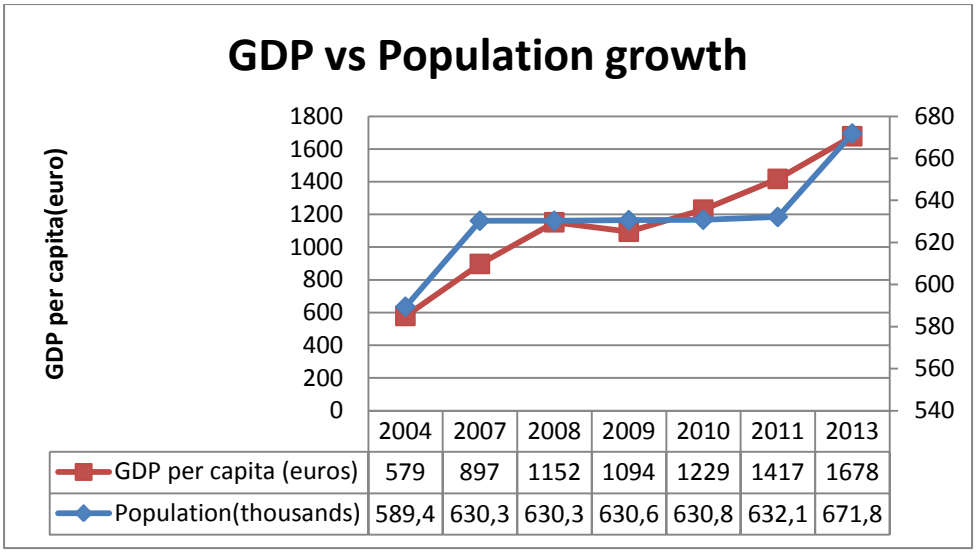


Figure 12 GDP per capita evolution and population growth (National Bureau of Statistics, 2013).

The figure 12 shows the relation between economical growth indicator and population growth. In a situation when the number of population is growing, the economy is also growing, but also and the level of technology is more developed, so it can be observed that in last year's the level of pollution from industrial activities decreased. That is because of the improvement of the technology at different enterprises. But still, these two factors, population changes and economic activity intensification, have lead on to the appearance of several direct consequences like changes in land use, loses of species, bigger amounts of emissions and discharges in ecosystems, disturbance of ecosystems and ending with changes in temperatures (climate change risk), health risks.

Climate change

Climate change is influenced by the amount of pollutants eliminated in the air, deforestation and other natural factors. Climate change is a time consuming process it can't be observed during a short period of time 5 or 7 years for example, but during the decades. The figure 14 is showing that climate change in the city of Chisinau can be a driver of change. The following figure shows the evolution of the quantity of air pollutants from the stationary sources in Chisinau city from (2004-2012). This amount of pollutants is only from stationary sources the numbers of cars in the city comparing to number of citizens in the city have a tendency to increase.

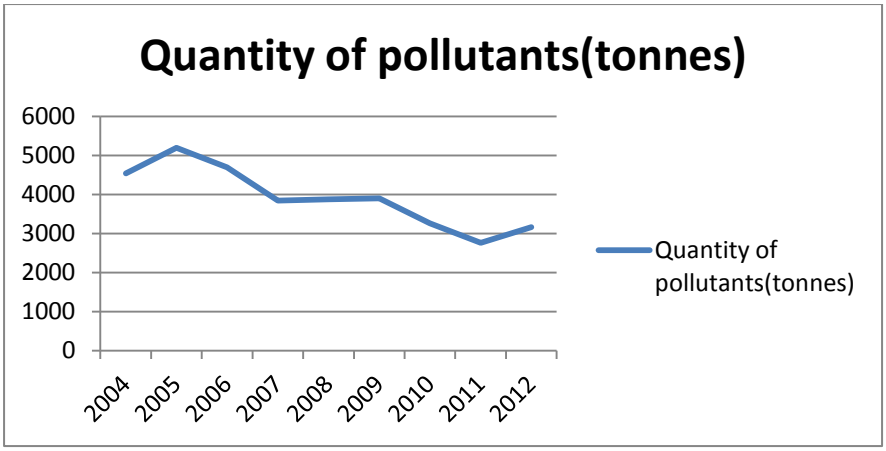


Figure 13 Quantity of air pollutants in the Chisinau city from stationary sources (2004-2012) (National Bureau of Statistics, 2012).

It can be observed a decreasing in quantity pollutants in the last years from the stationary sources, which is the good part. But the increasing number of cars in the last years affects dramatically the quality of the air in the city. For example the number of cars from 2009 till 2010 increased from 225.580 to 235.283 almost 1.04 times. Comparing to population growth trajectory than can be observed that number of cars in the city will increase even more.

Direct drivers

Climate variability

Figure 14 shows the evolution of the temperatures from 1891 to 2010, which concretely shows the increasing temperatures in Chisinau. The abundance of cars, combined with emissions from stationary sources and increasing temperatures, plus high humidity of the air and low wind speed makes the particles to stay on law high creating such called “island effect” and causing high risk of respiratory disease that affects citizens. Especially more vulnerable to this are pre-reproductive population and older population.

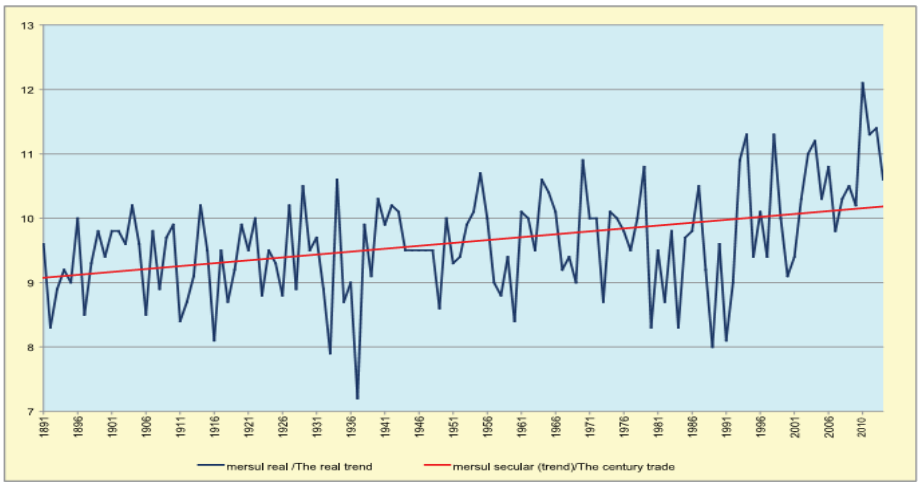


Figure 14 the changes of the temperatures in Chisinau from 1891 to 2010 (State Hydrometeorological Service, 2010).

All this means that excessive pollution is a factor that contributes to the variation of the climate in the city. Leading also to climate change, because during the years temperatures increased as you can see from the graph.

Insufficient technology

River is alimented by 6 small rivers and channels; in some parts is marsh and full of vegetation and needs cleaning. In industrial zone “Pruncul” (factory for producing asphalt) river is polluted by construction wastes and downstream were formed dams of wastes. In some places water from the river is used for car washing. The length of the drainage system of the city is 151 km but city still not have a WWTP for pluvial waters and they are flowing directly into the river. River has small quantities of water to dilute the water that are flowing in it (table 5). A part of waste waters are from some small entities connected illegally to the drainage system of the city. In the riparian zone on both shores of river are indentified discharged wastes.

Table 5 Bâc River characteristics

Bic river characteristics				
Annual average discharge in 2009, m^3/s	**Annual average discharge in 2010, m^3/s**	**Long-term average discharge (till 2010), m^3/s**	**Length, km**	**Total area of river basin, km^2**
0,14	0,27	1,47	155	2150

Downstream the city due to the discharges from WWTP (that is responsible to treat the waste water from the canalization system) and other economic activities river have a flow of 1,7-2,2 m^3/s. Sometimes river is

exposed to droughts that lead to a disastrous degradation of the river but also of the ecosystem around. In periods of high level of precipitations 4 sectors of the city are affected by the flooding on an area of 22,9 km^2. This flooded area is mainly located in the riverside zone because of the high slope grade on both sides of the river, low depth of groundwater table, low capacity of the river and also low grade of vegetation cover (Figure 15).

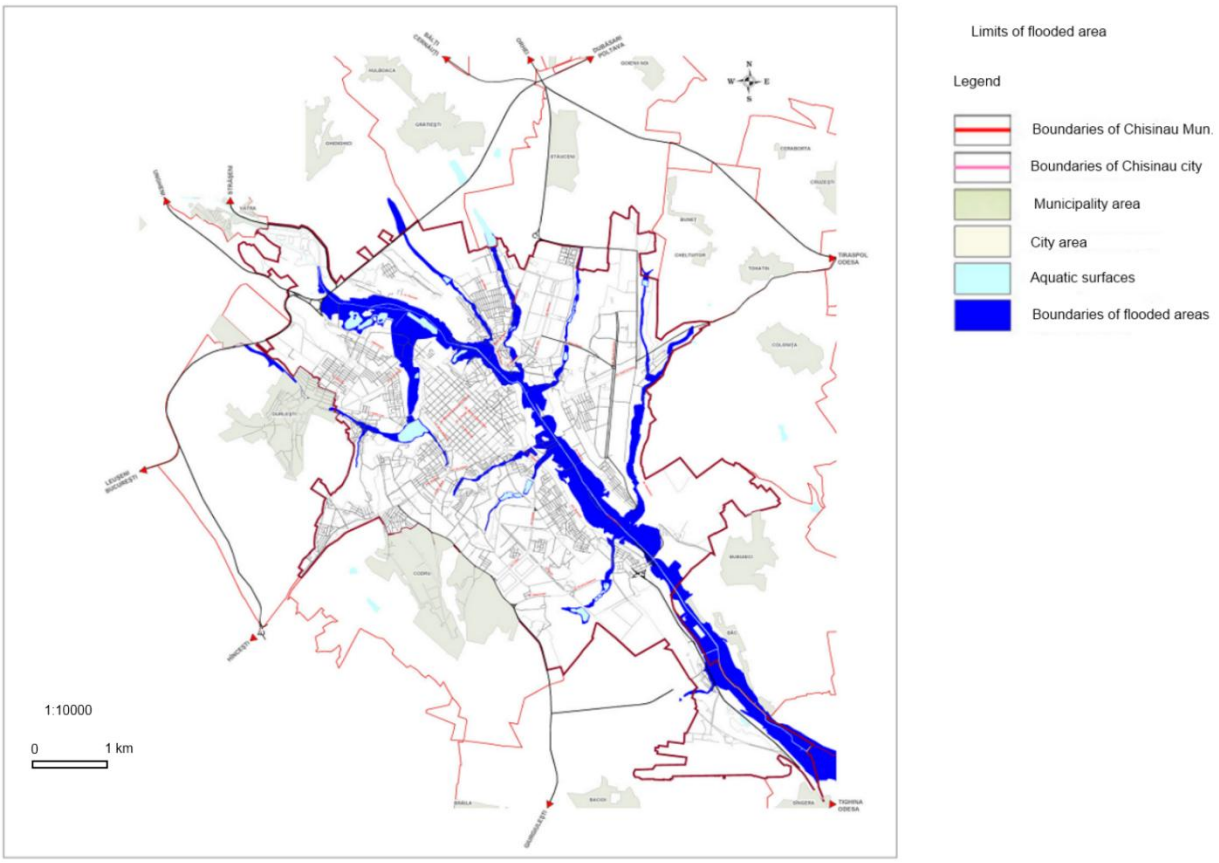


Figure 15 Map of flooded area (Territorial Management Plan of Chisinau, 2007).

Investigations showed that Chisinau have a negative impact on the ecological situation of the Bic river basin, admissible maximum concentrations of pollutants are exceeded three or four times even more (Mustea 2013). Figure 16 shows the concentrations (mg/L) of different parameters like ammonia - NH_4, biochemical oxygen demand – BOD_5 or (CBO5), and suspended matter – MS, comparing the upstream concentration and downstream the city scenarios with the AMC – maximum admissible concentrations.

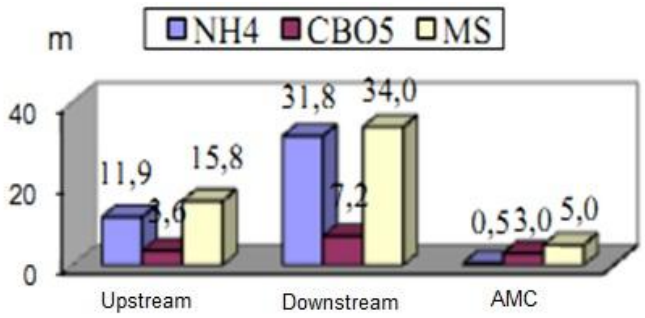


Figure 16 Comparison of the variations of concentration of different pollutants upstream the discharge of the Bic river and downstream, with maximum admissible concentrations (mg/L) in the Dniester river (Mustea, 2013).

Downstream the river after the municipality, villages situated on both sides of the river have problems with water supply, and quality of the water, the maximum admissible concentrations are exceeded at many parameters like nitrates, sulfate, and in some parts chlorides. A negative factor that influences the quality of the river is the presence of a lot of industrial activities and construction objects along the river, which results in waste waters discharges in the river (table 6).

Table 6 Indices of water consumption and discharged water in Chisinau by economic agents, by sectors, 2010 (Laboratory of Ecological Agency from Chisinau)

Indices of water consumption in Chisinau by economic agents, 2010													
Total	Captured water (Thousands,m^3)			Water uses (Thousands, m^3)				Wastewater discharged (Thousand, m^3)			Pollutants in discharged wastewater		
	Total	from surface water	ground water sources	Total	House hold uses	industry uses	For irrigation	Total	waste water treated insufficiently	without treatment	CBO_5 (tons)	MS (tons)	NH_4 kg
Ecological Agency from Chisinau													
Riscani Sector													
Total:	88510,5	85476,8	3033,7	86813,5	86709,9	103,6	0	57475,0	57278,9	196,1	1029,8	1024,0	1703306
Buiucani Sector													
Total:	443,1	200,1	242,9	443,0	149,5	293,5	0	415,3	43,6	371,7	187,17	149,3	5124,2
Ciocana Sector													
Total:	2094,4	1392,8	701,6	2094,4	265,2	1829,1	0	1363,3	193,9	1169,4	386,0	319,0	10676,6
Center Sector													
Total:	198,4	82,9	115,5	198,4	179,5	18,6	0,3	189	0	189	27,2	26,1	2898,8
Botanica Sector													
Total:	856,0	322,5	533,5	855,8	421,3	434,9	0	620,7	152,7	468	235,7	189,0	8382,2
Total:	**92102,4**	**87475,1**	**4627,2**	**90405,2**	**87725,5**	**2674,6**	**0,3**	**60062,7**	**57669,1**	**2394,2**	**1865,9**	**1707,7**	**1730387**

Figure 17 shows the evolution of the amount of dissolved oxygen from the upstream of the city of Chisinau, to the downstream of the city, the samples were taken in different points, Ghidighici is a catchment made on the Bâc river, near to the Ghidighici city, it serves like a retention pond for the

sewages from the city, but also for recreational activities and fishing. Other points represent the economic agents. The last one is a small city near the Chisinau, downstream. So from the graph dissolved oxygen is decreasing and when it is attending Singera city it has 1,5 mg/L of dissolved oxygen.

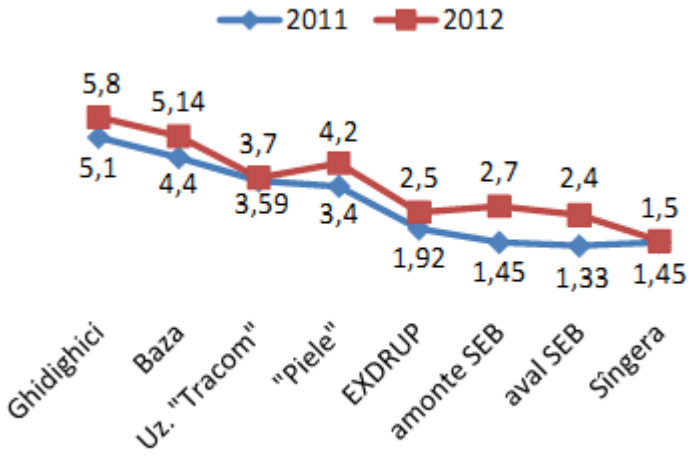


Figure 17 Quantity of dissolved oxygen in the Bic River 2011-2012 (mg/L) (Mustea, 2013).

The analyses of the sediments from the river made by Gillefalk M. and Lindberg F., 2013 showed that the concentrations of the substances are above the Lowest Effect Level for at least six out of eleven parameters that were analyzed and all samples contained at least one substance with a concentration above the Probable Effect Level. That investigation also demonstrated the impact of the Chisinau city on the river water quality, because the amount of petroleum products downstream was 10-100 times higher than upstream. The results also showed that Bic contributes to 58 % in increase of suspended solids per km^2 to Dniester River than what Dniester itself does to the Black Sea (Gillefalk 2013). In conclusion to this the ecosystem of the river is almost completely deteriorated. It creates a very unpleasant view of water quality of the river, resulting in losses of flora and fauna and creating a risk of contamination for ground waters also a risk for people's health.

Urbanization

Increasing in number of population needs more space, so new lands are given in exploration for construction of new residential objects or for creating new economic facilities. But also a reason why land near the river is often required it is because of the low prices to buy a square meter of land. River is much polluted that is one of the motives that influence the price of the land, and it is near to an industrial area so the view is not very pleasant. From 1994-2004 city almost exhausted its reserves of territories because of the lack of investments to construct new high buildings also there happened a lot of privatization activities of the industrial enterprises or they were sold at auctions in small parts neglecting technological profile

and future utilization of this constructions. In this period many of these green spaces were endangered and many of them disappeared completely. The problem of the area to be improved is that near the river is a lot of private ownership.

4.3. Stakeholders identification

Stakeholders are those who may be affected by or have an effect on an effort. They may also include people who have a strong interest in the effort for academic, philosophical, or political reasons, even though they and their families, friends, and associates are not directly affected by it (Work Group for Community Health and Development 2013). Stakeholders are very important in ecosystem services identification, because each of them can play an important role in the identification of the strength points and what are the weak points of the ecosystem. They can know better, what is the situation of the ecosystem, who is benefiting and who is affecting the ecosystem services? The stakeholders that were identified are shown in figure 18, and described by their interest and objective of the institution or community in the ecosystem.

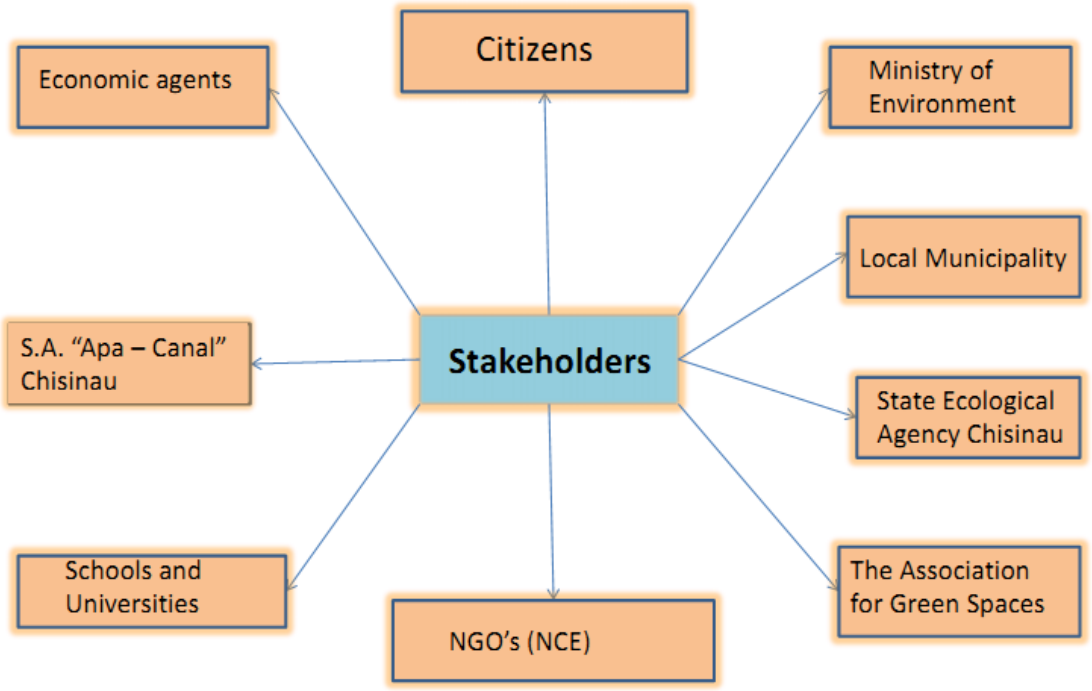


Figure 18 Stakeholders identification diagram

Ministry for Environment (ME) - is the central authority of public administration that elaborates and promotes state policy in the area of environmental protection sustainable utilization of natural resources, waste management, biodiversity conservation, geological researches, use and protection of subsoil

resources, hydro amelioration, water resources management, waste water treatment, and water supply, administration of nuclear and radiological activities, state ecological inspection, hydrometeorology and monitoring of environmental quality. It is implementing projects, laws and norms in the field of environmental protection, coordinates the economical activities that have a harmful impact on environment through ecological expertise of the projects, plans and programs and impact assessment with international and national agreements.

State Ecological Agency from Chisinau – it is an institution subordinated to the ME. Its function is to put in practice the national policy for environment. Executing, annually ecological inspections to all economic agents that have or can have an impact on the environment to check if they are respecting the standards and norms. They are promoting and elaborating the concept of environmental protection through educational programs. They are the institution that is giving the license for cutting trees required by the Association for Green Spaces from Chisinau; they are making the ecological expertise of a project giving the license for construction activities.

Municipal Council of the Chisinau – is the decision factor of the Chisinau Municipality. It is promoting and developing the strategy of territorial development of the city in order to solve local problems, to improve life quality of the society, economic growth and environmental quality. It has an interest to improve the quality of the river because it is playing an important role in the maintenance of the citizen's well-being. The Council takes decisions upon: institutional affairs; financing; strategies and development projects of the city; human resources management; property management, and the city delivery service.

Agency for Green Spaces – it is an institution that is subordinated to the local municipality and it is responsible for the management of the green spaces (cuttings of the trees, cultivation, maintenance etc). In the process of tree cuttings they need a special license from State Ecological Agency from Chisinau.

NGO's – is a stakeholder that is fighting for the improvement of ecological situation of the city and Bac River; Many of the NGO's are cooperating with ME to improve environmental quality. Also many of them are against economic activities from the city, which are polluting the air and water. Activity of the NGO's mainly constitutes in promoting environment to raise awareness of the citizens, economic agents and local administration, making educational programs and different researches showing the importance of the good quality of the river and air etc.

Economic agents – like was said above there are lot of economic activities that are taking place in the city, which affect and are benefiting from ecosystem services that are provided by Bac River basin. Mainly they are discharging waste waters in the river or their activities are located in the river basin. Many of them are private companies but also and public. Their industrial activity is affecting the quality of the water and citizen's quality of life, which are living downstream.

S.A. Apa Canal Chisinau – is a joint stock company with the Municipality holding 100 % of the share capital. The activities of the company are supervised by a board, with representation from the municipality. The interest that they have in the river Bâc is that they are providers of the water supply and waste water treatment services in the city. The Chisinau WWTP is located in the southeast part of the city approximately 7 km from the city center, beside the River Bâc into which the final effluent is discharged.

Citizens – are stakeholders that benefits from the ecosystem services and also can affect indirectly the state of the ecosystem. Citizens are directly or indirectly benefiting from the economic activities, consuming big quantities of products polluting the river with different wastes. If the consumer shares for more products, economic agents are producing more resulting in more waste waters and more pollution.

Schools and Universities – usually young people have a higher perception regarding the environmental problems. It is useful to include the most receptive stakeholders, and they are also affected by the ecosystem services depletion, it can be interesting to find out what is their awareness in relation to the quality of the river.

4.3.1 Stakeholder power and interest

Each of the stakeholders can play an important role in the identification of information about the details of the state of ecosystem services, and what is their perception regarding these services. Connections between stakeholders are playing an important factor in the decision-making process, this can help to identify the common interests between them and to reveal what are problems appeared.

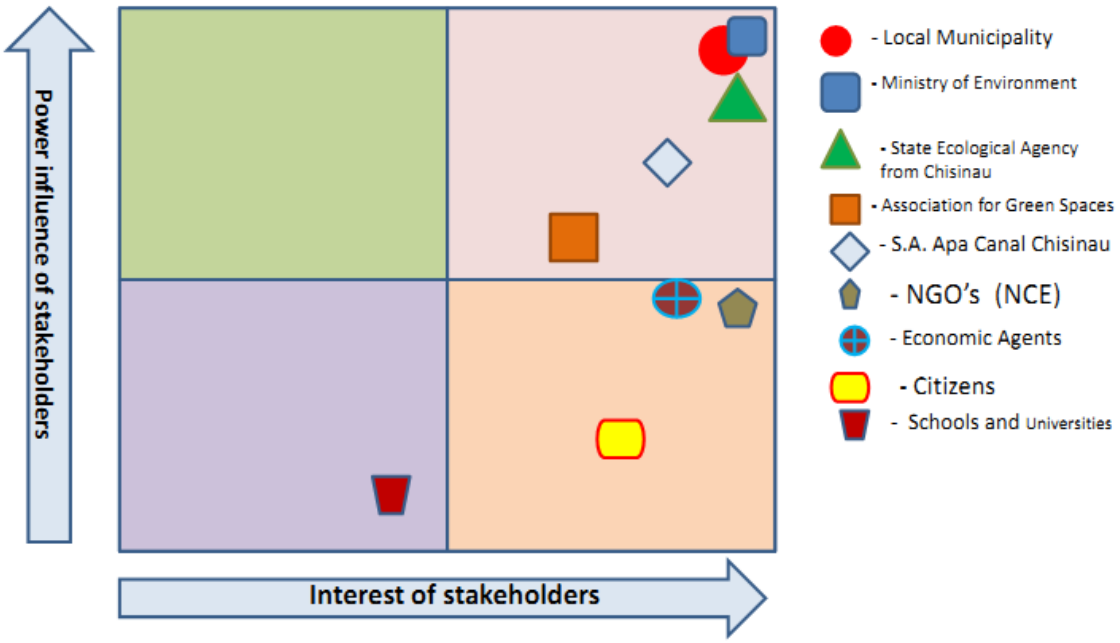


Figure 19 Stakeholders interest and power

In the figure 19 are shown the level of interest and power for each stakeholder. Ministry of Environment is the superior institution and it has a high interest for the protection of the river, in any of the decision regarding the project that are related to the protection or an impact on the state of the river basin implies the contribution of the Ministry of Environment. They have a high power of influence in taking decision and implement laws to contribute to the protection of the river. But the present quality of the river is showing that actions taken by the Ministry have a low degree of effectiveness. The activity of the Direction for the Socio-Ecologic situation from the municipality that is responsible for the emprovement of the environment in the city, is conducted by the environmental laws made by the Ministry of Environment.

Municipality is the second in power and interest after the Minsitry of Environment, in the strategical urban planning the policies written by them are directed to improve the state of the River Bâc so it is an important stakeholder that is responsible of the territorial organisation of the city and well-being of the citizens.

Also an important stakeholder is the S.A. Apa-Canal because they are responsible for almost all the discharges that they make in the river, and even if they are subodinated to the municipality they still have power of influence on making decisions, coming with projects of better management of the waste waters.

Association of Green Spaces – the green spaces from the river basin are managed by them so it is relevant to mention that they have interest and power of influence in this ecosystem, but they are still subordinate and influenced by the municipality, having a lower power.

High interest and infuence have State Ecological Agency from Chisinau that annualy is cheking the economic agents if they are respecting the law, and also are effectuating inspection controls on the river Bâc to verify if people are not washing their cars near the river, or if economic agents are not discharging illegally the waste waters.

From the NGO's was interviewed National Centre for Environment they are an organisation that have a high concern for this river and they have a high interest about it and tend raise their power of influence because they are in the good realtions almost with all stakeholders, mainly with decision factor stakeholders, like Ministry of Environment and Municipality.

Economic agents – most of them are affecting the river and benefiting from it discharging big quantities of waste water sometime without treatment. They are an important source of income for the city, and in such period when the city is developing, economy is an important pillar, and for Local Municipality is even more important than environment. Citizens, schools and universities are the stakeholders with the lowest power of influence but their interest is raising because they are still concerned about their health and its up to municipality to imply them and to collaborate with community to find the problems and solutions how to benefit better of the ecosystem services.

In the figure 20, are related the relations between stakeholders identified during the interviews and studies of the ecosystem services, it is useful to have a more specific knowledge about them to identify the problems of governance and how to solve them. Collaborations were identified between Ministry of Environment and local municipality in order to manage better but they still don't have so good relations. ME was saying that Local Municipality didn't came with any of the projects proposals, even if they have Ecological National Fond that can help municipality with financial part to improve the quality of the river basin. Also they have common problem of the waste disposal always making each other guilty because of that.

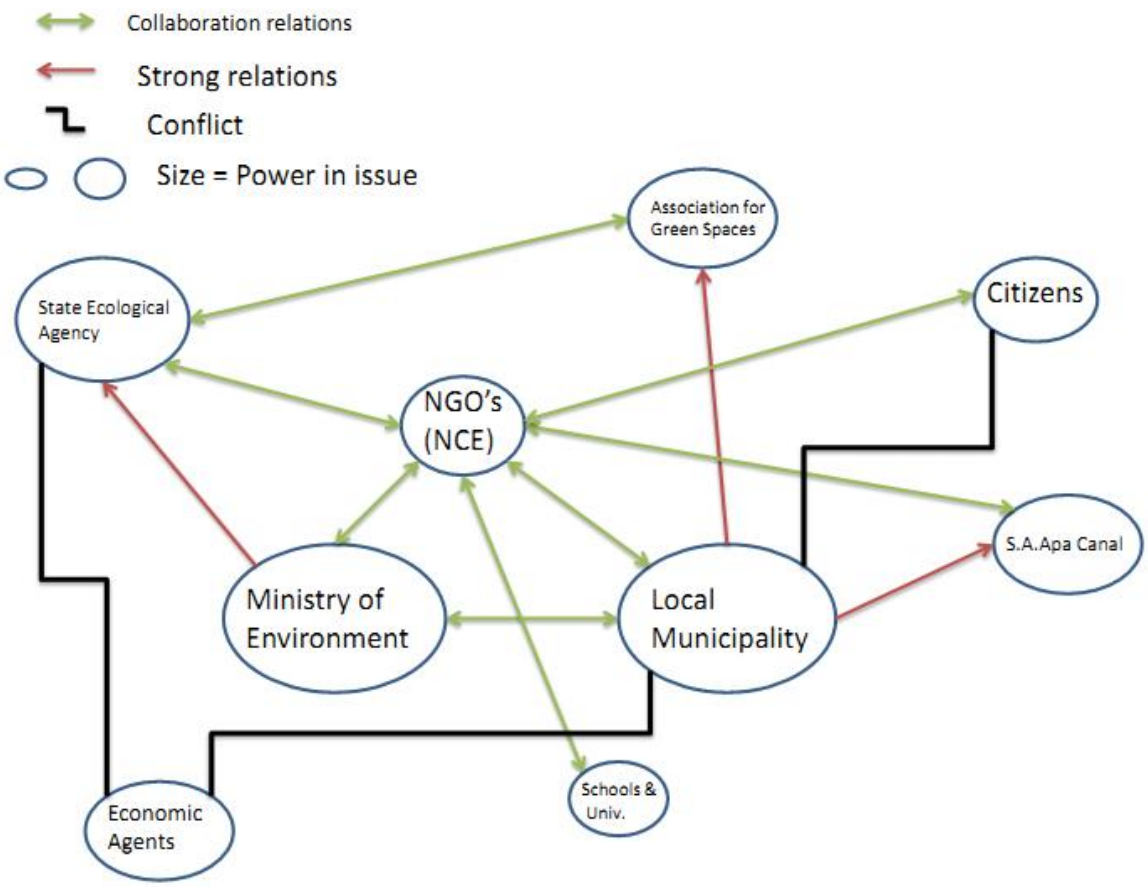


Figure 20 Relations between stakeholders

NGO's are collaborating almost with all of the stakeholders maintaining good relations to solve the problems of the river Bac, one example is National Centre for Environment is the organization that is trying to make meetings with representatives from different institutions to find solutions in within the Council of Bac River. But they don't have any relations with economic agents that are very important. They are collaborating also with authority for water supply and canalization S.A. Apa-Canal.

Municipality have in its subordination Association of Green Spaces and S.A. Apa-Canal they have strong relations with them but bad relations with citizens and economic agents first of them are making responsible the authorities of present situation of the river. Municipality doesn't have good relations with local citizens, because last ones are saying that Municipality is responsible of all the problems from the city.

Economic agents even if they are punished for breaking the law by State Ecological Agency (SEA) for excessive pollution they continue to do that, trying to avoid punishment through long process in court. The taxes that they pay are collected in National Ecological Fond. They are not in a good relation with State Ecological Agency

In terms of cutting trees that are old or represents a risk for public, Association for Green Spaces need a permission from the Ecological Agency to proceed with the works. This two are in relations of collaboration, especially first one which is dependent of the SEA. Relations between stakeholders are very important and sometime missing one of them can make difficult to reach proposed goal.

4.4 Policy analysis

In order to find the administration problems of the depletion of the ecosystem services provided by the river it was studied and analysed three policies one international, which is European Water Framework Directive. National policy that is, Water Law 272, from 23 of December, 2011. The last one is Strategic Urban Territorial Management Plan, adopted by Municipality Council in 2007.

European Water Framework Directive

Scope

To protect and restore ecosystems, in order to ensure sustainable use in the long term for people, business and nature. Includes good chemical and ecological status of surface water and also good for the quantitative and qualitative chemical analysis of groundwater.

Planning guidelines

1. Transposition and delineation of responsibilities of the various authorities, administrative process, coordination tasks;
2. Characterization, identification of pressures on ecosystems, impacts and economic analysis;
3. Monitoring and evaluation;
4. Setting objectives;
5. Development and implementation of measures.

Measures

- Consolidation of multidisciplinary water management;
- Implementation of environmental flow regimes to ensure that authorities and users are aware of the amount of water which the scheme required to achieve the objectives;
- Improvement of datasets in the quantification of water availability and demand and projections of future trends;
- Coordination with countries that share river basins in the process of RBMP (River Basin Management Plans);
- Involvement of agents and authorities since the beginning of the planning process;
- Coordination and consultation between the Flood Risk Management with the RBMP;
- Improve cooperation with the agricultural community, promoting a pro-active role for them.

National Policy

Water Law Nr. 272 from 23.12.2011, was elaborated having at the base directives adopted by European Council and European Parliament regarding water resources and their protection (Directive for Urban Waste Water Treatment nr. 91/271/CEE from 21st of May 1991; Nitrate Directive nr. 91/676/CEE from 12 of December 1991; Bathing Directive nr. 2006/7/CE from 15th of February 2006; Evaluation and flooding risks protection directive nr. 2007/60/CE from 23rd of October 2007 etc.

The scope of the law is:

- Creation of legal framework for management, protection and efficient utilization of surface waters and ground waters based on evaluation, planning and participative decision-making;
- Establishment of water utilization regulations and promotion of investments in water protection;
- Establishment of mechanisms of water protection, prevention of degradation and rehabilitation of aquatic ecosystem, progressive convergence and systemic protection and management of water resources based on the European requirements;
- Insure a sufficient water supply from surface water resources and ground water resources, good quality for a sustainable use;
- Establishment of a legal base for international cooperation in order to have a good management of water resources and protection;

Local authorities have following attributions:

1. Maintenance and management of water surface bodies, protection zones and riparian zones of rivers;
2. Inform civil society and other stakeholders about specific aspects of water domain, including restrictions and interdictions of water use;

Each adopted national policy in water resources use or waste water discharges should contain following policy guidelines:

a) Quantity and quality of water resources used by economic agents;
b) Volume of unused water resources;
c) Water needs in short terms, medium and long terms;
d) Investments priorities, taking in account insurance of efficient water supply and sewage services for urban population;
e) Special measures of prevention and pollution control;
f) Priority measures to climate adaptation, identification and elimination of water scarcity risks, drought and flood risks;
g) Programs of measures regarding implementation of quality requirements of water resources environment in conformity with European requirements;
h) Concrete terms of realization of this objectives, measures, actions and requirements;

i) For waste waters it is needed: designing, investment, construction, operation and exploitation of the collection systems of waste water treatment plants from urban areas in conformity with European Union requirements;

j) Identification and application of measures that will offer efficient costs of waste water treatment in rural places to minimize pollution.

Strategy of territorial development adopted by Municipal Council in 2007 and Urban Municipal Plan 2005 have developed several policies and programs in order to protect and improve the quality of environment in the city but also and river quality (table 7). For the implementation of these policies is responsible Local Administration.

Table 7 Policies made by municipality for the development of river Bac, (2007)

Policy	Program	Project
Protection of the soil, water and air/ reduction of the pollution	Protection of the effluents of the Dniester River	Improvement of the canalization for waste waters from households and industry
Initiation and application of municipal interventions in affected zones of anthropogenic activities.	Reduction and attenuation of the anthropogenic pollution.	Realization of analyses plan of natural risks and identification of technological defects
Protection of the flora and fauna of ecological importance at the local level	Optimization of the pollution sources	Replacement of the industrial activities from the riverside in other part of the city
Rehabilitation and extension of the green spaces in aquatic zones	Establishment of the green framework of the city	Realization of a plan of recovering and improvement of the green spaces along the river Bâc with 60 ha; Improvement of the riverside and its effluents

From the Urban Municipality Plan it was identified that there is a problem with a lot of constructions near the riverside even in the protection zone; the Law, for the Protection Zone and Riparian Zone nr. 440 from 27th of April 1995, is relating the following:

- In the protection zone is delimited the riparian zone of at least 50m for medium sized rivers in which economic activities are strictly limited;
- In the protection zone which on the river Bac is 500m is established a special regime for economic activities;

In 2010 under the Program “Non-state actors and developing local authorities” was developed a project in collaboration with Odessa Municipality from Ukraine, financed by European Union. The name of the project was “Construction of the drainage system and promotion and implementation of innovative actions for the adaptation to climate change”. The project was aiming the construction of the drainage system and prevention of flood risk in one region near the River Bac. But the project was started to be implemented in 2014 this spring.

The present strategy is still weak to face the problems that River Bâc is facing now. It should be developed a concrete territorial strategy for the development of the ecosystem of the river, which should contain the requirements from the national law for water resources protection (Law 272 from 23 of December 2011) and waste waters management law. At least all the projects that were proposed in the strategy for territorial development should be implemented, in order to ameliorate the situation.

5. RESULTS AND DISCUSSIONS

5.1 Interview results

Citizens and students

The present concept of ES is not known to the people, and when is addressed directly is not understood by them. That's why in questionnaires respondents were asked general questions about quality of the environment, how quality of the river is affecting their lifestyle, instead of asking them directly about ecosystem services provided to them by the river basin. This means that stakeholders perception regarding ecosystem services was rather subjective than objectively valued. During the study it was interviewed 15 citizens only 10 replied and were receptive. From universities were interviewed 21 students all of them replied.

Table 8 Explanatory of questionnaires and statistics

Stakeholders	Citizens		Students		Min	Max
Questions	Mean	Standard deviation	Mean	Standard deviation		
What is more important for you? (1=Economic growth paying less attention to environmental quality; 2=Environmental prosperity registering less economic growth; 3=Or paying attention to both of them environment and economy)	3,00	0	2,86	0,48	1	3
What is your concern about environment? (1=Low; 2=Medium; 3=High)	2,45	0,70	2,71	0,48	1	3
Did you ever participate to a public activity for environmental protection? (1=No; 2=YES)	1,45	0,52	1,90	0,30	1	2
From your point of view what is the quality of the environment? (1=Low; 2=Medium; 3=High)	1,36	0,52	1,43	0,60	1	3
What is the importance of the Bic river for the society? 1=Low; 2=Medium; 3=High.	2,45	0,72	2,43	0,60	1	3
Is the present ecological situation of the river influencing the health of the society? (1=No; 2=YES)	2,00	0	1,95	0,22	1	2
What is the level of influence? (1=Low; 2=Medium; 3=High)	2,55	0,71	2,67	0,58	1	3
Is the present ecological situation of the river influencing the security of the society? (1=No; 2=YES)	1,82	0,42	1,76	0,44	1	2
What is the level of influence? (1=Low; 2=Medium; 3=High)	2,55	0,85	2,10	0,77	1	3
Do you consider that taxes for water pollution should be higher? (If now the taxes for water pollution are for physical persons from 32,2 to 53,66 euro and for economic agents from 321,97 euro to 536,62 euro, depending of the contravention). (3=YES; 2=That's enough; No=1)	2,55	0,70	2,86	0,48	1	3
In case of yes, than how much they should be increased? (1=10%; 2=30%; More=3)	1,55	0,95	2,62	0,59	1	3
If there will be a need to pay for the recovering of the river, will you wish to pay for it? (1=No; 2=YES)	1,73	0,43	1,95	0,22	1	2
In case of yes, how much you will be willing to pay, depending of your monthly income (euro)? (Don't know or No= 0).	1,97	3,22	2,86	3,41	0	7,93

The results and statistical analyses, even though affected by a low number of responses, are presented in table 8. Citizens were chosen randomly almost all of them were living near to the riverside. Both environmental and economic development is highly valued by both groups. Concern about the environment is high, while both, citizens and students didn't participate so often to the cleaning or improvement of the river basin. In their opinion environment in the city have a low quality, being highly polluted, because of economic agents and inaction of the municipality. Majority of the respondents are considering that taxes for water pollution should be increased. Citizens consider that they should be increased with 10-20 %, while students said that taxes should be increased with more than 30 %. Majority of the interviewed persons expressed positively their willingness to pay for the river rehabilitation. The mean value that citizens were ready to pay was 1.97 euro/month and for students 2.86 euro/month.

Students are offering more importance and attention to the river ecosystem and valuing it at a higher rate. They were more receptive during the interviews. Even if they don't have a job and a permanent monthly income, majority of them being financially sustained by their parents, they were willing to pay for river recovering more than other citizens, because they don't value money so much. Citizens mean value of willingness to pay was lower, but this is because of the social status, salaries, and high prices of the products. They were considering that Local Administration should pay for recovering of the river. Instead of that many are ready to pay a small amount of money from their monthly income.Municipality made a web page where citizens can report different problems of their neighborhood. Number of reports related to ecological problems are, only 5. The problems classified by type are related in the following graph (figure 19).

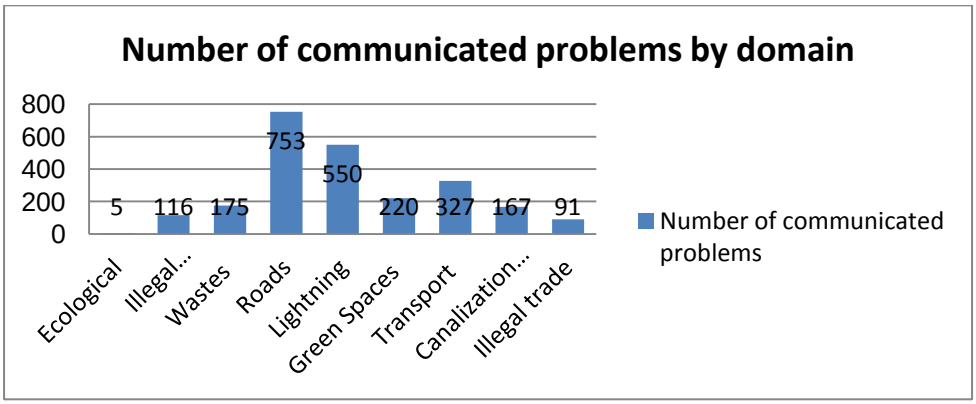


Figure 21 Problems that are most important for citizens of Chisinau city (http://www.alerte.md)

Many of the citizens remember that river was more beautiful in the past and it was possible at least to go for a walk on the riverside but now is much polluted and sometime smells bad, they are saying that the responsible for that are authorities and economic agents that are throwing wastes into the river. Authorities are not doing anything to clean the river.

NGO – National Centre for Environment (NCE)

From NGO's was interviewed National Centre for Environment. For NCE, Bic River is very important for Chisinau city, but quality of the river is very bad. In order to improve the quality they are collaborating with some institutions like Agency for Water Resources"Apele Moldovei", which is an institution subordinated to Ministry of Environment, also Ecological Inspection Agency, Centre of Ecological Investigations, local authorities, Centre of Public Health, General Police Inspectorate, Agency for Regional Development for central region, S.A Apa Canal Chisinau, other NGO's, mass-media, citizens, schools and universities.

In their opinion the actions and activities that are contributing to the degradation of the river basin are, illegal dams that are constructed upstream the city, the insufficient discharges through the spillway from the biggest dam Ghidighici that is constructed on the river Bic that is why downstream the dam, the river hasn't enough water. Bad sewage system of the city and insufficient treatment of the waste waters at the WWTP allows big discharges of pollutants into the river. Illegal discharges of waste waters in the river by the economic activities, solid wastes disposals, violation of protection zone in the almost all the areas of the river basin, pollution from the agricultural activities and car washing near the river. The responsible for such actions are, Ministry of Environment, Agency for Ecological Inspection, Centre of Public Health, Police Inspectorate, local municipality, economic agents, and citizens. They are noticing the lack of awareness and responsibility of these stakeholders; they are careless in relation to the quality and the protection of the river. Local municipality doesn't take all the measures to prevent the pollution.

The projects that they developed are made in partnership with General Police Inspectorate, in order to prevent and to punish the persons who are washing their cars on the shores of the river. They made the Council of River Bic where are participating representatives from local administration, Ecological Inspection Agency, Centre for Public Health, Agency for Regional Development. They are in good relations with local authorities from other districts upstream and they have very good relations with local municipality.

They are making education programs in schools in order to raise the awareness of school children for the protection of the river basin. Pupils are implicated in biological monitoring of the river, cleaning activities, planting of the trees in protection zones, and are organizing summer schools.

NCM is considering that to prevent pollution one of the solutions is to respect the legislation. The problem of this is the excessive corruption of the authorities responsible for environmental protection. And each of citizens should to be aware of the importance of the river ecosystem.

Ministry of Environment (ME)

The goal and objective of the Ministry of Environment regarding aquatic surfaces of the Republic of Moldova is the protection of water resources against pollution and exhaustion. In the RM there are more than 4200 artificial lakes and more 3600 rivers and small rivers, (however in last year's there are constructed water basins by private landowners and they are not registering them so the number of artificial lakes can be higher).

The objectives of the ME for surface waters are:

- Prevention of the pollution of the water resources;
- Protection and improvement of water resources quality of aquatic ecosystems, land ecosystems, wetlands that depend a lot of the aquatic ecosystems;
- Access of the public to the information on water and environmental quality in general;
- Reduction of polluted water surfaces

In conformity with the Law 272 for water resources from 23.12.11 (written practically in conformity with European Union Directives) the territory of the RM was divided in 2 hydrological districts, Dniester and Danube-Prut and Black Sea. It is planned to implement a Management Plan of this two hydrological districts. This plan will be elaborated in conformity with the stipulations from the Government Decision Nr. 866 from 1st of December 2013 for the approval of the elaboration of the regulation of hydrological districts management plan.

The program of measures are part of the Management Plan so if they will be applied for the hydrological district Dniester they will be applied also for the river Bic basin because this river is a part of this district. Monitoring of the Bic River quality is done by the State Hydrological Service, Laboratories of the Geographic and Ecologic Institute, Investigation Ecological Centre and State Ecological Agency from Chisinau.

ME is now implementing different projects of canalization and waste water treatment in different villages and even in the river basin. They are making different educational programs to raise the awareness of the population. They have an Ecological National Fond where they are collecting money for the investment in different environmental projects. In their collaboration with Foundation of Millennium Challenges they included the river Bic in a project for the identification of the water bodies.

In the identification of solutions in order to solve environmental problems they are collaborating with local authorities (implementing such projects like canalization or waste water treatment plant construction), Ministry of Health to monitor the health of the public and to identify the pollution sources. ME are working together with NGO's for example with National Centre of Environment (NCM) elaborating education programs. NCM at 21st December launched the initiative "Rehabilitation of the Bic River" a project

financed by an American foundation US Central and Eastern Europe Environment Foundation (UCEF). They are mentioning also about the Council of the Bic River that was formed by the representatives from different institutions and authorities.

Bic River is polluted; the reasons are different waste disposal problems, insufficient treatment of the waste waters. The concentration of the pollutants upstream is low comparing it to the concentration of the pollutants downstream the waste water treatment plant from Chisinau. Each year the household wastes are increasing with 200 % this was demonstrated by the General Ecological Inspection.

The obstacles into the implementation are lack of finance. Another problem is lack of awareness from local authorities for example in last year's they didn't implemented any projects for the Bic River protection or recovering, even if they are the biggest city situated in its area, and the biggest polluter.

At the moment the current legislation is effective but there are not enough ecological inspectors to check its implementation. That is why is not possible to detect all the legislation violence. The taxes for environmental pollution should be higher, because the penalties should be discouraging.

Local Municipality

The interview with Local Municipality was done in order to receive information on how much they care of the Bac River basin and what are the measures that they implement to protect the river.

From the analysis of the interview it was found that the objectives of the local municipality regarding the river are, to implement activities of pollution prevention and improvement of the rive protection zone, to transform the river into a recreational area, clean and attractive. Local Municipality does not have a monitoring program of the river, but the quality of the water is supervised by the Ministry of Environment through State Hydro meteorological Service and Agency for Water Resources.

They are implementing a project of cleaning of the river from sediments in the area of the city on a length of 3,6 km. Asked what problems river is facing, they didn't answered, but they are saying that is still hard to implement any protection measures because the majority of the lands are private and only a small part is public ownership. Local administration is implementing recommendations given by the Ministry of Environment. They find solutions to the problems that are communicated by citizens, economic agents and NGO's regarding ecosystem of the river basin. They are participating to public debates and presentations of the reports of the ecological situation of the Bac River.

In conclusion, the present situation of the river is showing that municipality is careless about the state of the river basin, but they are still doing something to decrease the impact like cleaning of the river, this is just to avoid floods that are happening in that region. The bad land administration permitted a lot of illegal construction and privatization. That is why hard to manage the river basin territory.

Association for Green Spaces

From the answers to the questions from Association of Green Spaces, it was identified that, they don't have the precise information about the river green area, like was said by the administration they don't even know how these spaces got under the subordination of the association. But they said that green spaces are not enough in most of the part of the river basin and in the city. They don't have any development plan or strategy that is elaborated by them, but the Municipality has a project in which they want to clean the river Bac, to pave the shores of the river and to plant more trees in the protection zone.

From the interview results was concluded that Bac river ecosystem is very important for these stakeholders, for health of the society and security and human well-being in general. But the current qualitative and quantitative situation of the river it showing that several stakeholders are careless regarding this ecosystem and services that it provides. That is because of the administration problems, low perception of the citizens even if they are saying that river is important, but their awareness is low. Economic agents even if they were not interviewed in most of the part their activities lead to pollution of the river. It's clear that Local Municipality wants to transform this ecosystem in a place for recreation services, and it could be valued also for this by the citizens. But they are not doing enough, and even when they start doing is only driven by elections campaigns, and then there is not enough time to finish the projects.

5.2 Quantification and evaluation of the ecosystem services

Ecosystem services are not something given by nature or by ecosystems as such. Rather, they are the consequences of ecosystem processes and components which humans considered to be valuable for their needs and desires. Ecosystem services are human benefits even if some humans do not recognize it. The question regarding which of these services is more important than others – than the answer is, the value of an ES-depends to a large degree upon the views and needs of stakeholders (Hauck 2013).

The question of the quantification of the ecosystem services was addressed by different scientists, and many of papers were written on this topic, studying the biophysical quantification were identified several indicators (Rubicode 2008). Each ecosystem services were analyzed in order to find information about the indicators that can be used to quantify, than evaluate ecosystem services from social and economic point of view.

The results obtained for the quantification and economic valuation of the ecosystem services are related in the table 9. The sources used to obtain this data are National Bureau of Statistics (2011-2013); Municipal Strategic Plan for Territorial Development (2007), report from the State Ecologic Agency 2010. The values for each service are explained after the table.

Table 9 Quantification and evaluation of ecosystem services

Ecosystem services	Quantification indicators		Economic Valuation	
	Indicators	**Values**	**Valuation methods**	**Values (euro)**
		Regulating services		
Water regulation	Area flooded (km2)	22,9	Cost to clean the river (cost replacement method)	159061,7
Waste water treatment	Pollutants discharged in the river (ton/year)	5304,106	Cost to treat and to transport the waste waters (Replacement cost method) mln. euro	32,2
Air purification	-	-	Annual expenditure for air protection made by municipality (2010) (National Bureau of Statistics 2011)	184081,3
Soil erosion	Surface affected (sectors)*	62	Cost of recovering the area affected by landslides in the municipality (mln. euro). (Avoid cost method)	1,3
Climate regulation	Green area (m^2/pers.)	30	-	-
Pollination	Green area benefiting from the service (ha)	2465,83	-	-
		Supporting		
Supporting of the species	Diversity of the species	-	Average cost of the square meter of land in this area euro/m2 (Hedonic pricing)	39

* In the annex IV are shown the sectors which are affected by landslides.

Regulation services

Water regulation – the insufficiency of green areas in the city and bad management makes this service not being used at its full potential. Thanks to the relief that city have, the area of the river basin during the high precipitation is flooded. Like indicator used for the quantification of water regulation service was used area that is flooded, because of the incapacity of the green spaces and river to prevent flood. For social valuation, was estimated the number of people that can be affected by flooding in this region, in accordance with the density of the inhabitants in the flooded area. Local municipality estimated the cost of cleaning 3,6 km of the river by marsh to increase the capacity of the river to avoid flooding. The length of the river on the territory of the city is 19,5 km. The total cost of the water regulation service is represented in the table 9.

Waste water treatment – river is the main receiver of the waste waters from the WWTP, industrial activities, households and pluvial waters. Quantification of this service was done taking in consideration the quantity of pollutants that are discharged in the river. Affected population in Chisinau is 671,8 thousands people. Economic valuation was done using the statistical data found from feasibility study made at S.A Apa-Canal Chisinau (Water Supply and WWTP Company) was estimated that the cost of a new treatment plant can be more 50 million euro. Value in the table is the cost to replace the service.

Air purification service - the pollution in the city is very high due to industrial companies and exponentially increasing number of cars. The lack of green area along the river is not enough to insure the cleaning of the air, that's why in the protection zone of the river the amount of dust, and harmful substances in the air is big. The service was valued in terms of annual spending of money made by municipality for air protection, that means that the amount of money that are written in the table 9 were spent on recovering the damages made by different sources of pollution to increase the quality of the air. From Strategic Territorial Urban Plan in 2007 it was proposed to increase the green area in the river basin from the city, but it failed. Data on the capacity of the ecosystem to purify the air was not found.

Soil erosion – from the concept for land resources management it was identified that in the city are 62 sectors that are exposed to landslides and the majority of them are located along the river Bâc that number served like a quantification indicator of the damage made to this service. From the data found on soil erosion it was identified that 662 households can be affected by landslides and other public facilities can be damaged. The cost for stabilization of 1 ha of landslides in the Republic of Moldova is 15924,92 euro (Andrieș 2004). In Chisinau municipality the area of landslides occupies 80 ha, in price it is included the cost of implementation of measures to stabilize 1 ha of land.

Climate regulation – high temperatures combined with excessive pollution affects the vulnerable part of the citizens, old people and children. Most of the people are valuing green spaces for this purposes to avoid the high temperatures and to breath clean air. The lack of information on how to evaluate this service made impossible to identify appropriate value. It was quantified by the area of green spaces per person in the city, which from the standards of urban development is enough.

Pollination – an important service that is sustaining all the vegetation in terms of social valuation it can affect all the people of the city, without it the present green area could not exist, at least all the flora that is dependent of the pollination made by insects. One method to value this service is the cost to replace it and to avoid damages, or cost of damages made to the city in the absence of this service (DeGroot 2002). This service was quantified by the area of green spaces that is benefiting from the service. Because of the absence of data it was not possible to give an economic value to this service. But pollination is sustaining all the green area, so in the absence of it will be affected and other ecosystem services.

Supporting services

Supporting of the species – land is serving as a habitat for all the species, but also as a support for industrial activities that are located in the river basin. The present situation of the river can't sustain fish or other species, like decades ago. The information obtained from citizens that years ago people were fishing in the river and their kids were launching paper vessels in the river is encouraging. But now water is polluted and it is hard even to try to go near the water table, because shores are full of weeds and reed. Data on the diversity of the species was not found, to make the quantification of the service can be also said that river basin is supporting 40 enterprises that are polluting the air, and are discharging waste

waters into the river. To calculate the cost of supporting services it was tried to use the hedonic pricing method. The price of 1 m^2 of land in the protection zone of the river is hundred times cheaper than other preferred zones from the city (Bacal 2007), it vary from 5 to 120 dollars$/$m^2$, the average value being 54 dollars$/$m^2$, the obtained value in euro is exposed in the table above (exchange rate 1 dollar$ = 0,73 euro).

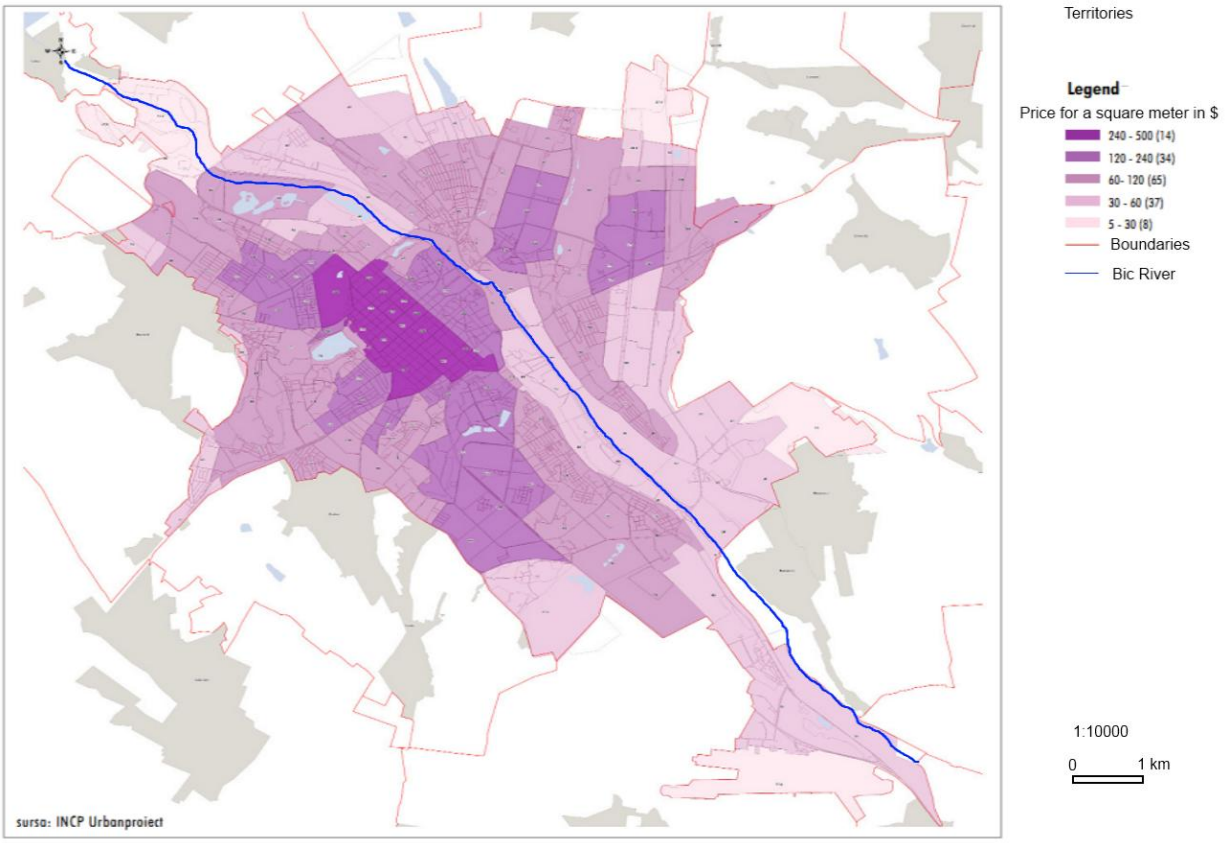


Figure 22 Map showing the prices of a square meter of land in dollars$/m2 in different regions of the city.

According to the Moldavian law Nr. 440 from 27.04.1995 for river protection zone and riparian zone the river Bâc is included in the category of medium sized river it has a length between 100 and 200 km, so the protection zone of the river have a width of 500 m and the riparian zone is 50 m at least. But this norm is not respected, on the territory of the protection zone of the river basin are located around 40 enterprises. Main reasons why land is used, it because is cheaper in that place (figure 4.3). The price is low because of the pollution of the river and unpleasant view; also because there is an increased risk of flooding as can be observed from figure 4.6. Ussually to the evaluation of land are used such indicators like destination of the land, functional category of the place (village, city etc.), geographic position, and individual direct benefits obtained as a result of the utilization of this land. But inidirect benefits and social benefits are not taken in consideration. Also the impact on the ecosystem services is not taken in consideration, because

this zone is multifunctional, serves like protection zone for the river, protection from floods, waste water treatment etc.

The river Bac have great potentials to offer to society recreational services, from that, that people are not benefiting now or are not valued by them at the moment. Parks and gardens are more valuable for the citizens serving for recreational purposes. That is why and lands near the parks and gardens are more expensive.

More valuable ecosystem services from the river basin for stakeholders are waste water treatment, and water regulation services. But also these services are more degraded by economic activities and citizens. If it could be taken in account the waste water that are discharged from all economic activities than river is responsible for more than 70 % of the income in Chisinau. The cost to repair the damages made to the river are higher than the gains obtained by economic agents polluting the river. Losing this services city is losing high amount of money by losing the income from the economic agents, and a lot of people can lose their jobs.

5.2.1 Ecosystem services and human well-being

The ignorance of the importance of the river Bac ecosystem for many years led to the degradation of ecosystem services provided to the people for free. During the centuries humans didn't took in account the importance of the ecosystem services for their future well-being and well-being of their children. In that way the depletion of ES was and is affecting life quality and social relations, because people chose single direction development, such like economic development. Many years natural resources were the reason to fight for, leading to genocides and conflicts between countries. The present problems of the river ecosystem exists because people have low salaries, they are taking care more about economical part than social or environmental situation. The measures that are implemented to prevent pollution by local municipality are not effective and combined with bad education of the citizens and other stakeholders; it results in low capacity of the administration to solve ecosystem services problems.

These said ecosystem services have a high impact on human well-being. Quantification indicators and valuation methods are important to quantify how much ecosystem are degraded, what are their capacity to provide services to people, what are their value. Human well-being includes such indicators, security and safety, physical growth/health, education, work, financial security, justice and fairness, human rights and freedom, place in community, cultural and spiritual identity.

The problems of ecosystem services identified are:

- Water regulation service and waste water treatment service are highly degraded, because of the high loads of waste discharged into the river;
- Undervaluation of ecosystem services by stakeholders that are concentrating only on direct benefits of the ecosystem services, meaning that they are taking in consideration only economic

development, instead of taking in consideration also of the social and indirect benefits of the services is changing the state of the ecosystem services;

- Low perception and awareness of the stakeholders leads to management problems of the ecosystem services, also influences the capacity to implement effective actions to prevent the pollution.

Ecosystem services that were identified in Bac river basin in Chisinau city are affecting human-wellbeing. From the citizens interviews was revealed that, ecosystem services degradation is affecting the indicators of human well-being, such like society health and security. From the quantification and valuation results it was revealed what is the level of affection of these services, what is their capacity to provide services to people. It was identified that ecosystem services degradation can influences people's health, jobs, safety and financial security etc.

5.2.2 Risks and obstacles in realization of the study

The missing interviews from the economic agents made the study more susceptible to errors all the information about these stakeholders was collected from the Urban Territorial Strategy Plan and National Bureau for Statistics. It was complicated to approximate their perception for the river basin, it was concluded that their awareness and concern is low. For economic agents it can be said that the present level of pollution and conflicts with State Ecological Agency, shows their concern for the state of the river and low participation in the prevention of the river pollution.

The interviews were not done, because of lack of time of economic agents, and indifference. Most of the chosen entities are big and medium industrial companies, private or controlled by the state, and they have conflicts with the institution mentioned above, they are not respecting the environmental legislation.

In result it was used statistical information and legislation, also and the data from the Environmental Annual Reports made by NGO's and Ministry of Environment. Those enable to approximate their perception and chose appropriate indicators to quantify the ecosystem services and make the economical evaluation.

5.3 Discussions: quantification of ecosystem services, is it possible?

One of the objectives of the study was to evaluate ES from social and economical point of view. From the results of the interviews made with citizens and students it was identified that their concern for the environment is high, than appears the question why the river is so polluted? The answer was found in the interviews with Ministry of Environment and specific NGO, and information found about Local Municipality's Urban Territorial Strategy Plan. The problems are described in this chapter above. Answering to the question how much they will be ready to pay (Contingent Valuation Method) for the recovering of river water quality the values are very high taking in account the power of national currency and their monthly income, 1,97 euro/month – citizens; 2,86 euro/month - students.

In terms of communication of ecosystem services to the people is impossible without saying how their actions can affect their own well-being, while quantification can help giving importance to this, transposing the affected ecosystem service in number of people that can be affected downstream. Like was saying Polasky S., 2011, “that many of the people understand ecosystem services like being something that they care about it, they care about fishing, they don’t care about their actions made upstream, that can affect the living inhabitants downstream the river, but if they will live downstream they will care about it”. The ecosystem services should be communicated to the people directly, using social and economical indicators. Is up to stakeholders to decide what is more important for them, for example, recreational services, or waste water treatment services, knowing their interest it can be prevented the excessive usage of the certain service. Valuation by using social indicators can be used to show the consequences of the harmful actions of the people, on the people. Many of the quantification and evaluation methods are used to include the non-use values of ecosystem services in the market, and also to inform decision-makers about the importance of the ES.

Quantification of ecosystem services is useful to use to identify how much a certain ecosystem service is harmed or if it is capable anymore of giving services to people. From the results that were obtained it can be answered that quantification of ES is possible. But it is depending of the available information on the ecosystem service, for sure if the ecosystem service is not used, the available information on it, is hard to find. Because of that it is needed additional studies; biophysical or social (like surveys to find out how much this service is worth to people), which also take more time.

Indicators obtained can serve as a base of starting a comprehensive study how to manage better the ecosystem services integrating the three pillars of sustainability, society, environment and economy to improve the state of the river basin ecosystem.

In a study made by Kallis, (2013) it was related in which cases is better to monetize ecosystems services. The study describes four criteria to which valuation should correspond to put a price on ecosystems services:

1. Will valuation improve the environmental conditions at stake?
2. Will it reduce inequalities and redistribute power?
3. Is it likely to suppress other languages of valuation and value articulating institutions?
4. Will it serve processes of enclosure of the commons (accumulation by dissposesion/neo-liberalism)?

This leads to the idea that not in all the cases is appropriate to value ecosystem services. Also not all ecosystem services have a price. There are many studies on how to value ecosystem services, but when living in a world that generates inequalities between people, it can be asked is it necessary to put a higher price for drinking water because of external benefits that it provides to people, if a higher price of the water will affect poor people. Some time no value is better than value.

6. CONCLUSIONS

1) This work identifies the ecosystem services and characterizes them using the data on a case study. The services are well characterized and quantified using the statistical data and biophysical data found on ecosystem services. The indicators that were used for quantification are: damaged area by floods -22.9 km^2; quantity of discharged waste waters into the river – 5304,1area affected by soil erosion – 62 sectors; green area per person – 30m^2/person; green area benefiting from the pollination service – 2465,8 ha. Quantification helped also to evaluate the ecosystem services from economic point of view.

2) Stakeholder's awareness regarding the problems of the ecosystem quality is high, but the efficiency of actions implemented to prevent the pollution is low. Citizens and students have a high perception of the ecosystem situation and recognize that river ecosystem have a high importance for the societal health and security. They expressed their willingness to pay at a value of 1,97 euro/month and students respectively 2,86 euro/month.

3) The variety of data found on ecosystem services provided by the Bâc river ecosystem, allowed to evaluate ecosystem services. But it was not enough to estimate the value of all identified ecosystem services. Such services like, climate regulation and pollination were not valuated.

4) Not in all the cases is appropriate to give a price to ecosystem services. Damages made to the ecosystem should to be quantifiable. Valuation made should to be objective and equitable. In case of conservation of a resource first it needs to be sure that the risk is approved and the investments will not be spent in vain, and also that environment will not continue to be degraded.

5) The degradation of river Bac ecosystem services is affecting the well-being of the people that are living in the city, also the pollution of the river is sharing for high expenditures to recover the state of the river basin. In that way present ecological situation of the river is affecting the livelihood of the citizens, and it makes responsible authorities to spend more money to improve the quality of the river.

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Annexes

Annex I

Questionnaire for citizens and students

List of questions:

1. ***What is more important for you?***
   - *Economic growth paying less attention to environmental quality;*
   - *Environmental prosperity registering less economic growth;*
   - *Or paying attention to both of them environment and economy;*
2. ***What is your concern about environmental protection?***
   - *High*
   - *Medium*
   - *Low*
3. ***Did you ever participate to a public activity for environmental protection?***
   - *Yes*
   - *No*
4. ***From your point of view what is the quality of the environment?***
   - *High*
   - *Medium*
   - *Low*
5. ***What is the level of the importance of the Bic river for the society?***
   - *High*
   - *Medium*
   - *Low*
6. ***Is the present ecological situation of the river influencing the level of health of the population?***

   Yes or No
7. ***What is the level of influence?***
   - *High*
   - *Medium*
   - *Low*
8. ***Is the present ecological situation of the river influencing the security of the society?***

   Yes or No
9. ***What is the level of influence?***
   - *High*
   - *Medium*
   - *Low*
10. ***Do you consider that taxes for pollution should be higher? (Now the taxes for water pollution are for physical persons from 32,2 to 53,66 euro and for economic agents from 321,97 euro to 536,62 euro, depending of the contravention).***
    - *Yes it should be higher;*

- *That's enough;*
- *No it should be lower;*

11. *In case of yes, how much should they be increased?*

- 10%
- 30%
- *More*

12. ***If there will be a need to pay for conservation or recovering of the river, will you wish to pay for it?***

- *Yes*
- *No*

13. ***In case of YES how much (euro)?***

Annex II

Questionnaire for Ministry of environment

1. What are the scope and objective of the Ministry of Environment regarding River Bâc Basin?
2. Has Ministry of Environment a network or a commission of monitoring of the River Bâc situation?
3. Has Ministry implemented a special strategy or project of the development of the River Bâc on long-term?
4. Which are the problems that is facing now river Bâc and who is responsible of them?
5. With what institutions, organizations you have relations of collaboration to prevent and solve the pollution problems?
6. What are causes of failure of implementation of all the measures that were taken during the years?
7. How do you consider the present available legislation is effective? And taxes for pollution should be higher?

Annex III

Questionnaire for NGO

1. What are the vulnerable points Bâc River and who or what is responsible for their appearance?
2. Are you collaborating with companies, administrative institutions, organizations, for mitigation and prevention of these problems?
3. How do you think local municipality takes all the measures to prevent and to solve the problems?
4. Did you implement any project in cooperation with local administration or Ministry of Environment?
5. How can you describe your relations with local administration, are they good?
6. What measures should be taken to solve the problems of river pollution?

Annex IV

Questionnaire for Association of Green Spaces

1. Are the green spaces from the river basin in the subordination of the Association of Green Spaces?

2. What surface have this green territories?

3. Strategy of development of green spaces in the region of river Bâc?

4. What are future plans regarding the protection zone of the river?

Annex V

Questionnaire for Local Municipality, (Direction of Socio-ecology)

1. Which are the goals regarding the development of the surface of the Bâc River basin in the city of Chisinau?
2. Has municipality a network of monitoring and protection of the river basin?
3. Has local administration a strategy or projects that could to protect the ecosystem services offered by the river?
4. Have local administration relations of partnerships with companies, governmental institutions, NGO's, community, which are participating in this projects of protection of Bac River?
5. Which are vulnerable points that are contributing to the pollution of the River?
6. What are the impediments that lead to the failure of the implementation of these projects?
7. What type of property are the lands used in the region of the riverside?
8. What is the importance of the river for the City?
9. What types of relations are between the citizens, Ministry of Environment and economic agents?

Annex VI

Map of the city with the territories affected by landslides

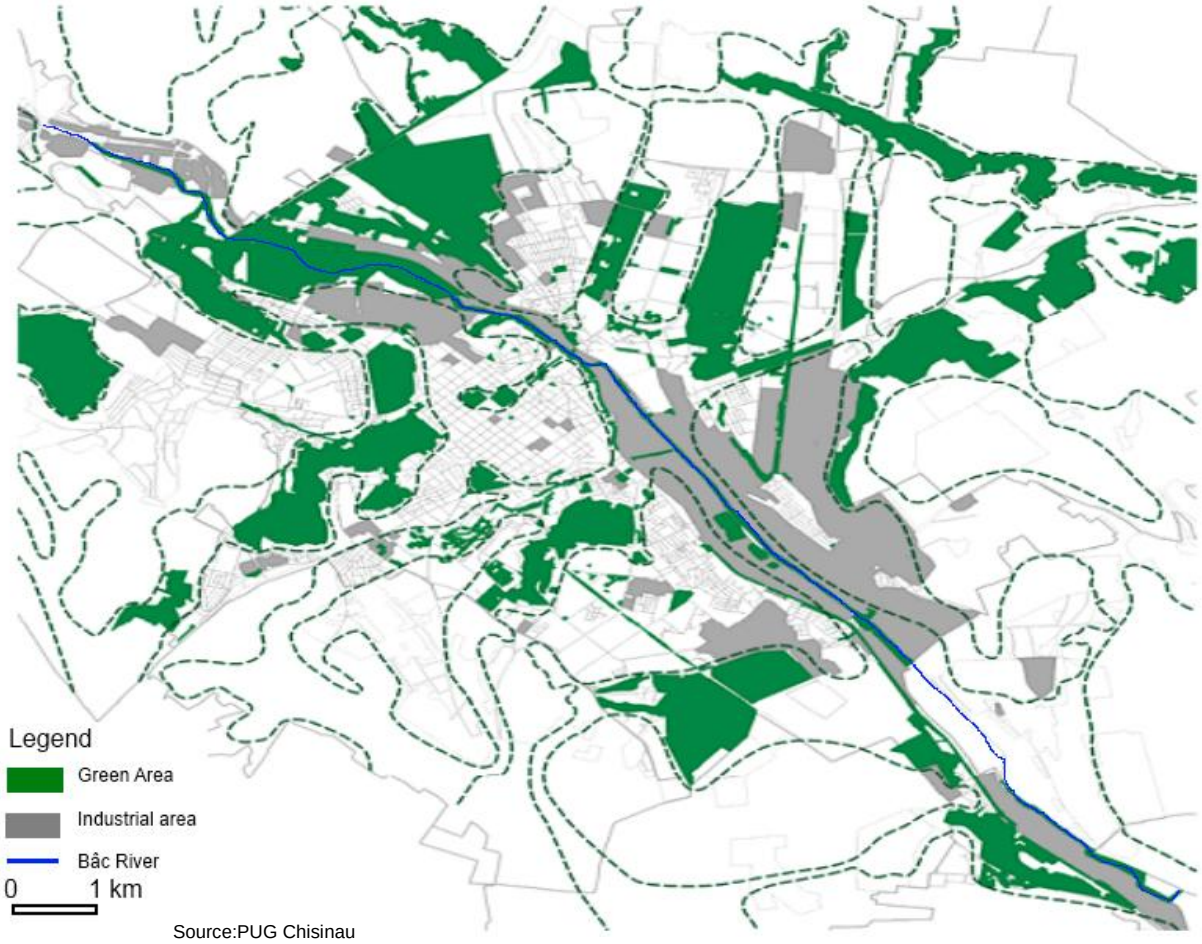

Figure 23 Territories affected by landslides