Content

Introduction

Around the globe, the understanding is growing that implementation of effective environmental policies guaranteeing rational use of natural resources is impossible without valuation of ecosystems. Particularly, valuation of ecosystems and their components is important for introducing "green economy" principles, within the framework of which valuation of nature capital is the basis of understanding the value of natural resources under direct and indirect use.

Ecosystems supply a wide range of services essential for our prosperity. They support economic and social development as well as the overall wellbeing of communities.

The demand of the humankind in fresh water, land, natural resources and other key ecosystem services (ES) is constantly growing. However, its level often exceeds ES availability leading to ecosystems' over-exploitation and reduction of their productivity. Despite this worrying context, supply of ecosystem services is often perceived as permanent and intangible, and their value is often underestimated and rarely integrated into decision-making.

During the Soviet time, for many years Kazakhstan acted as one of the major producers of grain, natural resources and heavy industrial goods – that oriented landscape planning towards the needs of highly resource-consuming economic sectors. This vector of industrial development led to enormous degradation and pollution of water, biological and land resources. In the 1990's and early 2000's, the natural resources management system shifted from a centralized to a decentralized model, i.e. largely privatized schemes, which did not reduce harmful anthropogenic impact on the environment. Due to the 1990's economic crisis, the top priority was rendered to robust development of all economic sectors, whereas environmental considerations such as ES were set aside and excluded from national development strategies.

Moreover, the current macro- and microeconomic processes – which are based on constantly depleting and degrading natural resources' market prices – by far, reflect the actual state of ecosystems. Therefore, within the framework of economic calculations it is important to consider indirect benefits of utilizing natural resources. It is, likewise, necessary to introduce the concept of ES total economic value allowing a more objective assessment of direct and indirect benefits of ES supply.

Since 2010, Kazakhstan has been gradually formulating its policies linked to transition to "green economy" and environmental sustainable development.

The Concept of Transition to "Green Economy" of the Republic of Kazakhstan adopted in 2012 as per the Decree of the President N.A. Nazarbayev states that "integrated management of natural ecosystems shall be done in accordance with the principles of sustainable development with the aim of increasing their value and economic potential". Currently, Kazakhstan is also working on implementing an environmental-economic accounting system (SEEA), assessing the overall level of natural resources' consumption and forging models to calculate the genuine savings index. These schemes intend to determine the level of the gross national wealth as well as identify the degree of natural resources depletion and environmental damage. In more strategic terms, their introduction will foster the country's shift from conventional economy based on intensive use of natural resources to a resource-saving and environmentally oriented paradigm.

Numerous techniques and approaches of valuating ecosystem services exist in the world. The information on the assessment of water use in the Aral-Syr Darya area (Kazakhstan part) within the UNEP/CAREC Project "Mainstreaming ecosystem services into sectoral and macroeconomic policies and programmes in the Republic of Kazakhstan" is presented below. Project outputs are based on the data derived from the social accounting matrix (SAM) and water indicators for two target provinces (Kyzylorda and Southern Kazakhstan Regions) of Kazakhstan. The project was unique in the sense that an ecosystem component of the Aral Sea region for the first time received a monetary manifestation. The modeling was built on a general equilibrium algebraic model with static and dynamic components and various input data. The model focused on water's contribution to the GDP of the two target provinces and allowed to elaborate three policy options and possible development scenarios. More detailed brief on the applied modelling approaches and proposed scenarios is provided below.

I. What are ecosystem services?

Ecosystems are a combination of living organisms and their environment interacting with each other. Ecosystems vary in size and provide a wide spectrum of benefits/services to all living organisms, including humans.

The benefits/services of ecosystems are usually segregated into 4 main categories:

Provision (supply) services are biological and natural resources directly utilized by people to ensure wellbeing as well as economic and social development. Such services include food, fuels, water, various natural materials used to manufacture goods, industrial and household products, medicine, etc.

Regulatory services (functions) include natural cleaning of water and regulation of air quality, protection of soil from erosion and landslides, climate regulation, maintenance of biological and genetic diversity of flora and fauna. Although this type of services is less evident to humans, it possesses a significant economic and environmental value as it regulates most important natural processes on the Earth.

Cultural services include services of spiritual, religious and/or recreational purpose and value for humans like cultural and architectural monuments, natural landscapes, recreational areas, monuments of nature, etc.

Support services ensure operation of ecosystems, thus, guaranteeing an uninterrupted supply of other ES. They include reproduction of nature capital, decomposition of substances, natural water and nutrients cycle, weathering and erosion, etc.

Thus, ecosystems provide communities with a variety of services most of which we receive indirectly, so their role is hard to assess. For example, forest ecosystems are important for people in terms of timber production, while their other functions, e.g. water saving and filtration, have no associated value. These ES are often disregarded by environmental decision-makers, which leads to gradual degradation of ecosystems. In addition, some directly used ecosystem services like minerals, water and timber are valuated only based on their market price – other (indirect) benefits of their availability are not taken into account. Contribution of natural resources (ex., water) to gross domestic product (GDP) is almost never assessed also. Such lacunae allow decision-makers neither to comprehend the actual level of use of different types of ES, nor to analyze the process of social and economic development depending on their contribution.

II Methods for ES valuation

Lately, the awareness of the importance of ecosystem services and their valuation has been raising. According to the Guidelines on Economic Valuation of Water-Related Ecosystem Services (CAREC, 2013), ES economic valuation may be divided into four main stages:

- collection of necessary information (statistical data, previous studies, surveys, etc.);
- preliminary assessment and ranking (selection) of ecosystem services most significant for a specific area;
- economic evaluation per se (calculations, evaluation of benefits from ecosystems in monetary and quantitative terms);
- assessment of analyses outputs and development of improvement proposals.

Some of the ES valuation methods in accordance with the Guidelines[1] are presented below:

The market price method. The method suggests calculation of the amount of produced natural products and/or raw materials and its multiplication by the market price of target products or services. The method is applied to nature products utilized by people directly;

The alternative cost method. This method is also called the method of alternative service supply or benefit replacement and is used when it is difficult to determine the cost of services/goods because they are used free of charge. The method allows analyzing the possibility and value of supplying services (e.g. water supply or water treatment) from alternative sources. It can be, for instance, alternative supply of drinking water from an underground instead of a surface source. It demonstrates the alternative cost of service – in our case, water, from underground sources – in market prices. One drawback of this method is the often high cost of proposed alternatives;

The hedonic price method is based on the difference between prices for the same product in presence and in absence of a given ecosystem benefit, i.e. the difference in the cost of an apartments in the same compound with a view over a beautiful landscape and without it. The price difference represents the cost (value) of the landscape;

The expenses method (transport and travel costs method) is based on calculating the expenses incurred by tourists due to visiting a particular area. All associated costs (travel, accommodation, meals, entrance fees, etc.) are multiplied by the total number of tourists to get the total value of the tourist market of a given territory;

The value transfer method is based on using the valuation of any service performed earlier in a target country or abroad. The method requires adjustment of valuation depending on the level of the national/territorial GDP per capita and account of inflation and income rates. The method is primarily used in cases when it is impossible to assess a given ES in a country or to minimize the costs associated with conducting an independent valuation by way of utilizing outputs received within the framework of already performed valuation(s). This model can be used in relation to practically all types of ecosystem services;

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[1] Guidelines on economic valuation of water-related ecosystem services. CAREC, 2013.

The contingency valuation (stated preference) method suggests identification of people's willingness to pay for a particular service, i.e. its availability, or for improving the state of an ecosystem and its services. The method can be applied to valuate any type of ES.

As can be seen from the above, valuation of ecosystem services is possible based on different approaches and methods, with the choice usually depending on the availability and reliability of critical data.

The UNEP/CAREC project "Mainstreaming ecosystem services into sectoral and macroeconomic policies and programmes in the Republic of Kazakhstan" aimed to evaluate water availability as a services supplied by the Aral- Syr Darya Basin ecosystem to local communities. The study model was based on the theoretical framework and corresponding empirical methodology presented by Roe, Smith and Saracoglu [Roe, Smith & Saracoglu, 2010 [2]]. It has dynamic and static components. The static component focused on the behavior of two types of agents – consumers and producers – as well as the results of their interactions. Producers combine capital, labor and other inputs to produce final goods and services. Consumers use income to purchase final goods and services today and/ or save it for future consumption. Groups of these agents contact each other within the "goods and services markets". Assessment of their interactions allows determining the ultimate allocation of resources among competing demands. The dynamic component suggested the optimal volume of savings and enabled to model consumer decisions over time.

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2 Roe, Smith, Saracoglu, 2010

III. The project "Mainstreaming ecosystem services into sectoral and macroeconomic policies and programmes in the Republic of Kazakhstan" funded by UNEP and coordinated by CAREC in partnership with the Department of Applied Economics, University of Minnesota (USA)

Experts from the University of Minnesota, in close cooperation with national experts from pilot areas of the Aral-Syr Darya Basin, implemented a pilot study designed to estimate the value of provisioning services provided by water along the basin. The analysis was conducted within the framework of the UNEP funded project "Mainstreaming ecosystem services into sectoral and macroeconomic policies and programmes in the Republic of Kazakhstan".

The project aimed to enhance understanding of water based ecosystem services (ES) contribution to gross domestic product (GDP) and to build the capacity for integrating this approach into the planning process, including the sectoral and macroeconomic levels. Integrating the approach into the planning process hinges on using the wealth value of water (described below) to guide policy decisions.

3.1 MODELING THE ECONOMY ALONG THE ARAL-SYR DARYA PILOT AREA

The pilot study focuses on two provinces in Kazakhstan – Kyzylorda and Southern Kazakhstan (SK). These two regions constitute the last leg of the Syr Darya River – a river that flows through the territory of four states – Kazakhstan, Uzbekistan, Tajikistan, and Kyrgyzstan. Irrigated agriculture are the primary beneficiaries of the water flowing though Kyzylorda and SK, receiving over 85% of water drawn from the river.

The model was designed to project the level of GDP and other variables from 2007 through 2057 years and was based on the following data:

- data from the two pilot areas related to water supply, water availability and agriculture;

- GTAP[3] - based Social Accounting Matrix (SAM) for Kazakhstan;

- Word Bank publications and data;

- other relevant sources and Kazakhstan national statistics.

The Global Analysis Trade Project is one of the most extensive repositories of SAMs to date. GTAP is a global network of research centers and institutes of strategic development, involved in the quantitative analysis of international issues. GTAP activities are coordinated by the Center for Analysis of Global Trade at the Faculty of Economics and Agriculture, Purdue University.

A SAM is a double-entry accounting construct that summarizes the income and costs generated across sector in a country or region over a given period of time – typically one year. In addition to accounting for the economic activities across all sectors in the country/region, and it tracks the payments to capital and labor, household expenditures on final goods and services, and regional and international trade. A SAM also provides insights into the economic links among productive sectors and institutional units in an economy.

The GTAP factor accounts included capital and labor. Kazakh experts disaggregated the original GTAP factor account categories into capital, labor, land and water. This disaggregation makes it possible to measure the economic contribution of land and water.

[3] Global Trade Analyses Project.

The choice of sector aggregation is consistent with the structure of Kazakh production, and with the objectives of the pilot study. First, South Kazakhstan produces virtually all cotton grown in the country, while Kyzylorda produces almost all of the rice. Both of these sectors are major water users, with rice accounting for at least 90% of Kyzylorda water demand, and cotton accounting for at least 50% of SK water demand[4]. Other agriculture in each region uses water, too, but for most years no single product used as much water as cotton in SK or rice in Kyzylorda. As such, we aggregate all non-cotton agricultural production into SK other agriculture (SKOA), and all non-rice agricultural production into Kyzylorda other agriculture (KOA).

Manufacturing constitutes a relatively small share of Kyzylorda and and SK value-added, and household consumption accounts for a very small share of water drawn from the Syr Darya. Given the focus on water, and the fact that manufacturing and services account for little of the water drawn from the Syr Darya, the team decided to integrate Kyzylorda and Southern Kazakhstan manufacturing GDP into an aggregate manufacturing sector for all of Kazakhstan. The same reasoning was applied to the service sector.

Hence, SAM and the model based on it has seven sectors:

- cotton production
- rice production
- other agriculture in SK
- other agriculture in Kyzylorda
- Rest of Kazakhstan agriculture
- All of Kazakhstan manufacturing
- All of Kazakhstan services

[4] Cotton's share of water demand began falling after 2010.

3.2 MODEL'S OUTPUTS AND FINDINGS

The study had two major objectives. One was to develop a model for measuring the value of water in the economy. The other was to investigate the potential for using the model to understand the impact of policy on natural resource values and wealth, and to provide a tool for better managing water resources in the pilot region.

To satisfy these objectives, the team developed a conceptual model that captured the important features of the Syr Darya basin and the rest of Kazakhstan. The dynamic, general equilibrium model included the seven sectors described above, and had capital, labor, land and water as productive factors. The general equilibrium feature of the model captures complex interrelationships inherent in an economy – e.g., feedbacks among sectors – that single industry studies are unable to accommodate. The dynamic feature allows for measuring wealth effects of policy, and provides a longer run view of the impacts of decisions made today on future generations. A dynamic model also provides a glimpse into how an economy might naturally use resources over time, and whether those uses are "sustainable."

Three variants of the model were implemented: (i) The baseline scenario is a "business-as-usual" model; (ii) The second scenario examined the potential benefits of letting target provinces trade water use rights; (iii) The third scenario examined the potential benefits from increased efficiency of water utilization through rehabilitation and reconstruction of irrigation networks. In each scenario, the key indicators produced by the model were: (i) current and future GDP and sector value added levels; (ii) the value-added contributions of water and land in rice and cotton production, and in "other" agricultural production; and (iii) the "asset value" of these resources per sector.

1st Option: Baseline Scenario

The baseline simulation examine the economics of the status quo policy, where South Kazakhstan and Kyzylorda both receive a fixed amount of water: cotton and rice producers receive 634 million m^3 and 2 321 million m^3 of Syr Darya water each year respectively, while SKOA and KOA receive 1 202 million m^3 and 536 million m^3, respectively. The rest of Kazakhstan agriculture (ROKA) is endowed with 9 306 million m^3 of water. We assume 60% of the basin water drawn from the Syr Darya eventually reaches the fields.

Simulation results suggest that for a fifty year period beginning in 2007, Kazakhstan agricultural value added will in **about 40 years**.

Even though agricultural production (value added) increases, its share in GDP falls over time.

In case, if GDP provided will grow in each agricultural sector, including cotton and rice production in the long term, and if land and water resources stay at a relatively constant level, the **contribution of these resources in the country's GDP will grow along with the general growth of the economy.**

Water's contribution agricultural value added in the Aral-Syr Darya basin is approximately 13% in 2007. The contribution is most pronounced in South Kazakhstan "other agriculture, and is a result of the relatively high productivity of water in that sector.

In 2007, the contribution of land and water resources in the GDP of the whole country amounted to about 2%, but according to the model, it will decline to just under 1% in 50 years.

SAM and water quantity data suggest the shadow value of water differs across sectors, with South Kazakhstan other agriculture valuing water the highest. On average, for the farmers of other agricultural sectors of SKO the returns from water or income derived per unit of water, will be 2.5 times higher than that for cotton producers, and 8 times higher than for rice producers.

Taking into account the long-term growth contribution of water resources in GDP, the unit shadow price of water increases monotonically over time. The pace of technological growth and labor force growth in Kazakhstan will lead to an increase in the contribution of water in GDP in each of the sectors.

The cumulative value of land and water will be accompanied by rising short- and long-term **income for farmers.**

The main conclusions from the analysis of the baseline scenario are based on an assumption that within 50 years the situation will continue in accordance with current politics.

Firstly, if the predicted **long-term** profitability per water unit increases, the policymakers can be confident that agriculture will remain reasonably competitive with manufacturing and services in the capital and labor markets (markets factor), i.e. competitive enough not to shrink as the economy continues to grow.

Secondly, if unit **shadow water rents vary across sectors**, it may be worthwhile setting up a commission to investigate the potential gains from **water trading,** based on more detailed analysis of the potential benefits of this.

Thirdly, the stock value of water and land is a scalar index that reflects the value of current and future profits farmers will receive from land and water rent. If the stock values of land and water increase as per the proposed policy (e.g., water trading or purchasing Syr Darya water for Aral Sea restoration), it can be assumed that **farmers will benefit from the policy.**

2nd Option: Water Rights Trade Between Provinces

This scenario examines the potential long-term benefits from allowing pilot regions to «trade» use rights. The model assumes trading will occur such that the unit shadow value of water is equal across all (Kazakh) agricultural sectors along the Syr Darya. As mentioned in the baseline scenario, SKOA producers place the highest value on additional water. Meaning, if given an opportunity to acquire additional water use rights, they would use it.

Estimations show similar to a baseline scenario growth of GDP rate in each targeted sector for the period from 2007 to 2057, except rice production and services which are developing a little **faster in the conditions of trade water rights.** According to the model, most of the added value of rice-sector products will be shaped by the proceeds of a reimbursable transfer of water for the benefit of other sectors of agriculture in SKO.

According to the model, in this scenario, Kyzylorda region will produce very little rice, and scenario data indicate that the sector will receive nearly all its value added from selling/renting its water use rights to other agricultural producers along the Syr Darya – namely farmers in SKOA.

The results show differences in the growth of value-added agricultural products, compared to the baseline scenario. The main conclusion in this regard is that water trade rights would lead to a decrease in revenues from the production of cotton, rice fields, as well as other branches of agriculture of Kyzylorda region and income growth in other sectors of agriculture SKO.

At the same time profit margins of other agricultural sectors in SKO would be sufficient to compensate the other agricultural sectors in KO, cotton and rice-growing sectors for the lost revenue by reducing production.

Proposed scenario will have other indirect consequences. These factors (the establishment of the equal price of water, production in growth in other sectors of agriculture in SKO) would contribute to increase of value added for both: water and land.

In general, the more efficient distribution of water leads to increased stock value of natural resources, in other words to **increased value of ecosystem** services provided by these resources.

With regard to this scenario, it is important to note that during the development of any action it is advisable to pay attention to the impact of the proposed measures on income distribution. Thus, in case of increase in the value of assets accumulated by implementing of water rights trading system, it can be declared that this will provide enough income for farmers, despite the losses due to reduction of production.

3rd Option: Improving Irrigation Efficiency

The third scenario examines the economic impact of improving irrigation system efficiency in each of the target agricultural sectors in the Aral - Syr Darya Basin. For this scenario the baseline assumption is that irrigation system efficiency or in other words, the share of Irrigation Water Supply (IWS) reaching crops is only 60%,, Then gradually increasing irrigation efficiency is modeled for over a 50-year period with 85% of the IWS reaching crops by 2057.

The patterns of GDP growth and development in Syr Darya agriculture are similar to those obtained in the baseline model. As in the baseline and "water rights trade" models, production in each sector increases over time, and agricultural added value doubles within 40 years. The added value of manufacturing and service sectors doubles much faster - in less than 20 years.

Improved irrigation efficiency increases the water endowment of each sector, which, in turn, fosters better productivity of capital, labor and land in agricultural production of the Aral - Syr Darya Basin as a whole. These forces enable agriculture of this region to build up its production relative to the base model levels.

Percent difference in sector value-added growth for 2007-2027 compared to baseline scenario look as follows: for cotton production is 8%, for rice production – 17.6%, whereas for SKOA and KOA it is slightly less or equal to 5%.

In accordance with the model, **the growth rate of the Syr Darya agricultural output increases** at the expense of industry and service sector growth (very slightly) over the 50-year period (2007-2057).

This result pinpoints an important aspect of ES services and natural resources valuation, i.e. in general, resource availability should enhance the competitiveness of sectors drawing on associated natural ecosystem services.

In accordance with the model with water more abundant relative to the base model, water unit shadow rent rates are lower at each point in time across each sector. For each sector, the total shadow rental value – or shadow **value-added** – is higher in the increased irrigation efficiency model relative to the baseline case: both cotton and rice value-added is higher than in the base scenario by 7% and 14% respectively. An increase observed for SKOA and KOA is 4.1% during 2007-2027.

Because water will become more available and less scarce in this scenario, its unit stock price should decrease. On the other hand, more water makes land more productive and, hence, the increased land values. Given the structure of agricultural production, improvements in irrigation technology lead to a nominal increase in natural asset wealth.

The scenario with enhanced irrigation efficiency is more profitable for **farmers** when compared with the baseline scenario, as the **net gain in wealth increases**. These results suggest **investment in irrigation infrastructure repair should yield benefits to regional agriculture and to population employed in Syr-Darya agriculture**.

It should be mentioned, that these results, however, likely underestimate the gains from more efficient irrigation as modeled here, increased water endowments of farmers are spread over the same level of cultivated area. A more realistic specification would allow **cultivated area to increase** due to improved irrigation efficiency.

In addition to the increasing number of hectares earning rent, this modeling adjustment suggests increased water productivity. Doing so, would undoubtedly boost the stock value of the ecosystem (natural resources).

Conclusion

The actual valuation of ecosystem services is a relatively new area of investigation. The corresponding methods help to estimate the real economic cost of the services supplied.

In the context of natural resource depletion and increased demand for goods and services, which people produce using ecosystems, there is an urgent need for this kind of analysis allowing us to see the true value of natural resources and their real contribution to GDP.

This is especially important for Kazakhstan in connection with the adoption of the Conception of Transition to "Green Economy". The transition primarily targets sustainable use of existing national wealth and rational exploitation of natural resources by the national economy. This is possible only under the condition of acknowledging that natural resources' contribution to our economic wellbeing should be subject to valuation and monetary manifestation. Mainstreaming this approach into economy will foster perception of each and every ecosystem component as a valuable resource, long-term and efficient use of which will pay dividends not only to the economy but, likewise, to local communities and the whole nation.