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Tomorrow's World Requires a Sustainable Hydro-Economics Concept

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ABSTARCT

It is clear that humanbeings has destroyed the nature since the last quarter of the 19 th Century with start of industrial revaluation .In the beginning of the 21st century we faced extraordinary natural disasters as well as rainfall and temperature changes, rapid ice melting in different part of the world. All these mostly have occurred under the effect of climate change and forced a paradigm shift from demand or supply oriented harsh water development to use current water resources as efficient as possible. This logical approach is getting larger and larger as the years go by. Therefore near future water management concept will shift from building new and more water supply systems to better operating existing ones. The variation of water values in time and space has increasingly motivated efforts to address water scarcity and reduce water conflicts. Hydro-economic models represent spatially distributed water resource systems, infrastructure, management options and economic values in an integrated manner. In these tools water allocations and management are either driven by the economic value of water or economically evaluated to provide policy insights and reveal opportunities for better management. A central concept is that water demands are not fixed requirements but rather functions where quantities of water use at different times have varying total and marginal economic values. The 2015 World Economic Forum Global Risks Report ranked water as the number one risk factor. All these other sources of stress on water systems will be affected and/or exacerbated by climate change. This paper reviews the vital role of Hydro-Economics concept in a sustainable water management that will implement full cost recovery policy under the effect of climate change. It also focuses on the growing problems of allocation of water resources among competitive uses

***Keywords*:** Hydro-economics; water economics; water future; water value; water risk; water price

1. INTRODUCTION

Objective of this article is to draw attention on the financing challenge for the water and sanitation sector reviewing the global experience in financing mechanisms. Over the past years, the water and sanitation sector has recognized the increasing importance of finance, though an important change in approach has occurred.

During the 1990s, most discussion on financing the sector focused on service provision, particularly assessing the possibility of meeting the cost through public funds versus alternative resources (10). Private sector investments were assumed to carry the burden within the sector; but this has generally not happened, resulting in widening financing gaps.

It is now well recognized that financing water and sanitation is not just an issue of mobilizing the required volume of investment. Equally important issue is supplying water for all with affordable price. Finally, effective, efficient, and transparent use of water resources and supply it affordable price have gained recognition. This is the financing challenge for the water and sanitation sector in the new millennium.

1. 1. Why do we need new Water Economics Concepts ?

Economics applied to water management has a long and distinguished history. Some basic concepts integral to understanding hydro-economic models are described below. Several recent introductory textbooks provide accessible but in depth coverage of the economics of water resources (18).

Climate change effects on water resources has brought several uncertainties that require advanced hydro-economics models for sustainable water management. The models should provide for integrated assessment of physical and economic impacts of changes in water demand, climate conditions, water resources management objectives and policies, and other system constraints on a basin's water resources.

Most of the basins are expected to experience reduction in water supply and increase in water demand due to climate and demographic changes. Therefore it is needed to highlight significant economic loss incurred by water users due to water scarcity and inefficient water use as well as benefits of adaptive water resources management through implementation of more efficient management policies.

Without water, neither small businesses nor major global industries can function. It is obvious that water is ironically both taken for granted and serves as the engine of the economy. Sustainable development needs sustainable water management and water supply. It is therefore that many companies are giving preference to areas where water risks are lowest.

Water resources are essential assets, and effectively managing and leveraging them is a shared economic responsibility of business and industry, farms and factories, individuals and communities.

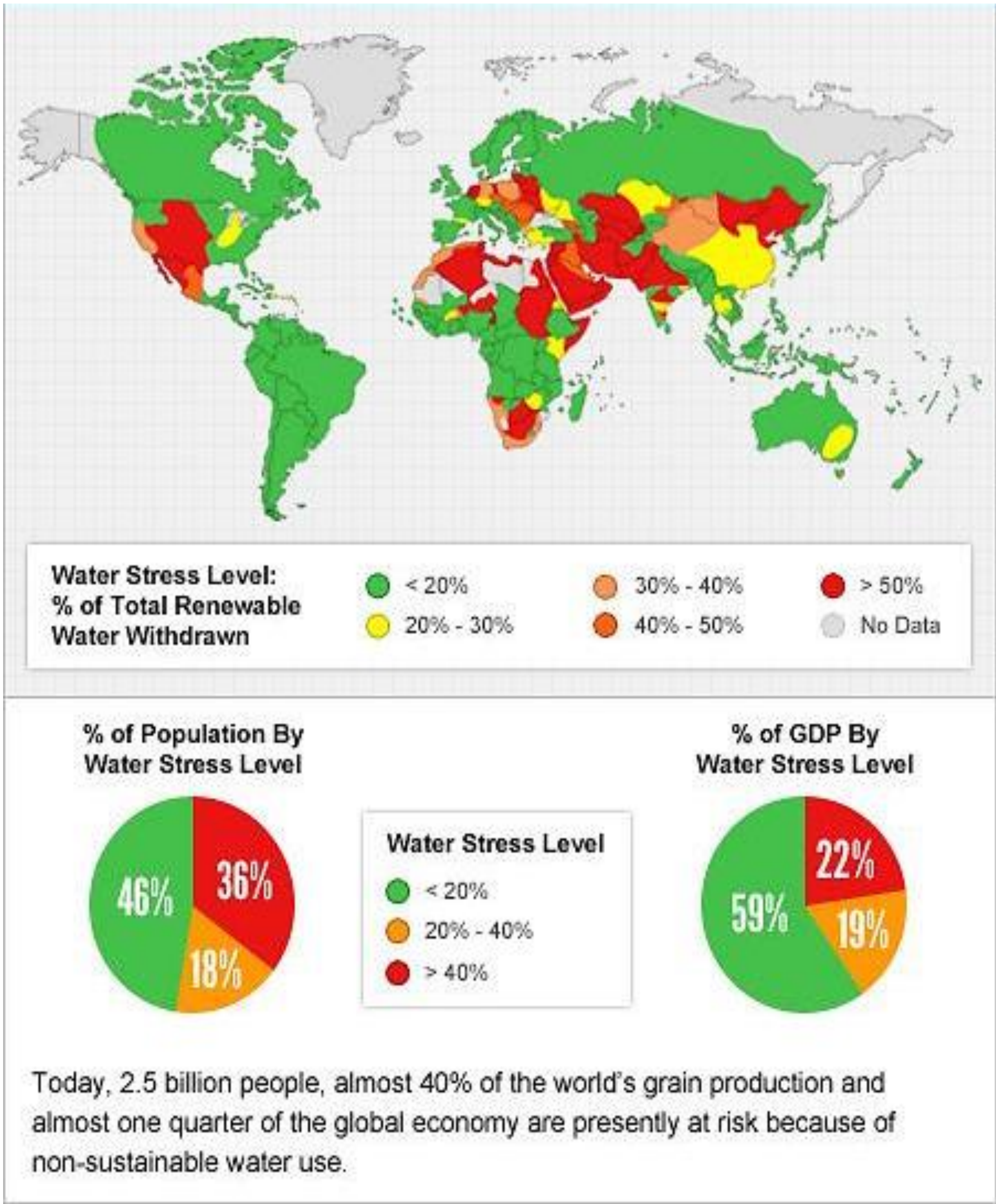

Figure 1. The world water stressed areas

1. 2. Economics of Climate Change

The latest research information in climate variation and prediction studies shows that several new modes of climate variations are discovered in the last decade and the studies that unravel those new modes and their processes are scattered. Moreover, climate models have made great strides in predicting modes of climate variations several seasons ahead.

Climate change effects force decision makers to reach consensus on potential win-win water management and development options. In a Win-Win scenario, both parties gain more by cooperating than they would otherwise have gained on their own. It's not a matter of all sides reaching an optimal compromise; it's a matter of all sides gaining something.

There are several research on the economics of climate change: its impact and strategies to address it. **Economic research has aimed to estimate the impact of climate change** to predict and evaluate adaptation and mitigation strategies (20).

The scientific research on climate change established a base of knowledge that is crucial for economic analysis. First, it established the relationship between various human activities and the buildup of greenhouse gases. Second, it predicts that climate change will lead to:

- 'Migration' of weather in the sense that warm weather will move from the equator toward the poles, increasing average global temperatures,
- Rising sea level that will flood coastal areas, and
- Increased variability and instability of weather.

Scientific research emphasizes that all these changes will affect and be affected by water resources.

The economic literature on climate change has emphasized:

- Measuring the economic cost of climate change (16,15),
- Designing and measuring the cost of alternative mitigation strategies and
- Designing and measuring the cost of alternative adaptation strategies. This line of research aids in the selection of economically effective and politically viable climate change interventions.

1. 3. Cost Of Climate Change

The literature on the economics of climate change is evolving and it includes many areas of emphasis, for example climate change and water. Much of this literature addresses the impact of climate change on agriculture through its impact on water systems and land use in different regions. Another body of work emphasizes the relationship between climate change, water, energy, and infrastructure (Hellegers et al. 2008). And other studies emphasize the economics associated with sea-level rise (12). The paper by Johansson and Kriström presents a welfare economics framework to assess the impact of severe weather events resulting from climate change (9).

The economic impact of climate change through increased water scarcity or flood under various policy regimes has been the subject of several of the papers. The papers address regions that are especially vulnerable to adverse water-related impacts due to climate change.

The impacts of climate change on water systems include changes in precipitation, melting of snow cover, and extreme weather events like floods and droughts. Severe floods in South East Asia have been more frequent disaster since last decade.

There is certainly a growing recognition of the costs of climate change. In the climate change–water realm, the most readily measured cost is likely that of flooding. (Arent et al. 2014) in the IPCC Working Group II Chapter 10 report on a range of flood related economic costs, as do others. Jongman (8), for example, state that between 1980 and 2012, the annual cost of flooding was in 3 excess of US$ 23 billion (in 2010 prices)

For instance in the period of preperation of this article (in 3 July 2016) we heard that 32 million people in 26 provinces across China have been affected by severe flooding,186 people died and 45 are missing,1.4 million people have been relocated and 56,000 houses have collapsed (BBC News 2016).

1. 4. Rising to the financial challenge in water sector

Many of the papers includes developed methodological approaches aimed at addressing specific implications of climate change. But the policy note by Ringler and Ebrahim provides a broad perspective on the main challenges of Editorial economic research on climate change and water. They argue that given the inter- action between water and climate systems, and the fluidity of water over space and time, developing responses to climate change that affect water systems require interaction between economic agents and governments that should be guided by economic principles.

Rising temperatures will also affect cropping patterns and thus, water demand. One key challenge is the reduction of water supply for agriculture and the increase in its variability. But these changes would not affect all regions equally.

It is obvious that the poor will bear a disproportionately larger share of the negative impact of climate change on water systems as well as increasing water price. The impact of climate change on water systems will be correlated with the impact of other economical and environmental factors like environmental cost, resource cost and full cost recovery that would enhance water prices when supply is negatively affected (20).

This emerging new full cost recovery approach requires more hydro economical research to establish appropriate models for water financing and water pricing. It is clear that hydro economists need to provide content of this terms in an applicable manner.

In fact economics is not enough to assess alternative policy proposals, but economic tools and mechanisms (markets, tradable permits and other incentives) can also be incorporated in the solution to climate change and water problems. The literature on the economics of climate change and water is a work in progress

That requires developing framework to assess the costs and benefits of different responses to climate change in order to make the appropriate choices. These important frameworks will require interdisciplinary collaborations with scientists in physical, biological and social sciences, as well as working closely with engineers and policy makers (Zilberman 2015).

The reasons for rising to the financial challenge are considered in the context of three key trends given below (6);

1. The looming "water crisis", which is essentially a water management crisis. OECD 2012 projections indicate that global water demand will increase by 53% between 2000 and 2050. This will increase the pressures on water-related ecosystems and exacerbate tensions between economic sectors. Meeting the demands that society places on the water sector will require both major investments and widespread reforms – in terms of governance, policy coherence and financing.

2. The emerging "green growth/green economy" paradigm. This should facilitate the implementation of good water resources management in at least three aspects:

(a) increasing recognition of the need to protect water resources and water-related ecosystems as economic assets,

(b) better allocation of water resources (in terms of economic productivity), and

(c) increasing attention to investments in nature - based/green infrastructure (such as upper watershed forested lands, wetlands, aquifers and floodplains) as more efficient alternatives to hard infrastructure.

3. The evolving discourse on "financing water for all". Water financing discussions were traditionally focused on advocating increased financial resources centred on drinking water supply and sanitation. In recent years, more attention is being paid to sustainable financing (bringing realism and a strategic view to balance the requests for financial resources with the likely revenues of the sector from users, tax-payers, and external transfers). Only recently has a discussion started on financing water resources management.

1. 5. Water, energy and the water economics

Water and energy are vital resources making life possible and worth-living. Water energy is one of the less disturbed energy generations into ecosystem. Water used in energy generation directly or indirectly lowers the price of the energy we consume. But it comes with costs. In general water allocated to one use leaves less water for other human economic activities that benefit us directly and less water for the environmental flows that benefit us indirectly.

Non-renewable energy used today (coal, oil, nuclear and natural gas) leaves less energy for use tomorrow. Renewable energy from hydro, solar, wind, and other sources can — theoretically — be used indefinitely, but these sources met less than ten percent of domestic demand in 2011 (U.S. Energy Information Administration).

People have been discussing the water-energy nexus which means that water is necessary to produce energy, but energy is necessary to produce water (via pumping, treatment, and so on).for the past few years. It is mainly because of that they are worried that a lack of water will reduce energy availability or that a lack of energy will reduce water availability. The impact, in either case, would be detrimental for our economies and our quality of life.

If we focuse on water as a resource that can be used for economic activities. Most water resources is managed, priced and distributed by local monopolies, whether it's an irrigation district delivering water to farmers or a utility delivering water to residential and industrial users. These monopolies often sell their water at the cost of delivery — covering the fixed costs of pipes and variable costs of treatment and pumping (Zetland 2013).

Johansson, Per-Olov**,** Kriström**,** Bengt **(**9) studied on a kind of water use conflicts that is becoming more and more common and important as time goes by. Under the increasing energy demand and environmental services the arising question is that How to best manage moving water in times of increasing demand for electricity as well as environmental services. How should decisions be made between water use for electricity generation or for environmental benefits?

This issue may be one of the most arguable point in near future about profit-resource cost proportion in competitors. It is not only because of the more sectoral water allocation in hydro electricity but also recalculation need "water resource cost" for hydro electricity generation. Renewable energy unit cost generally doesn't include "resource cost". except for for water use taxes in hydro electricity generation.

2. NEW WATER POLICY OBJECTIVES

Traditional water policy objectives have been mostly related to economic and social issues: protecting populations and economic assets from floods, providing the population with safe drinking water as well as sewage collection transport and disposal, and providing economic activities (agriculture, mining, hydropower generation, industry and commerce) with water as an input for production (6).

More recently, environmental policy objectives were added to the water policy agenda: protecting water-related ecosystems. New water policy aims to achieve multiple objectives such as protection of ecosystem as well as "achieving water security" .One of the multiple policy instrument has been accepted as water pricing that is a family of instruments within a broad water policymaker toolbox.

2. 1. Water Management and Statistical Methods

Empirical statistical downscaling methods are becoming increasingly popular in climate change impact assessments that require downscaling multi-global climate model (GCM) projections (Fig. 2). Several statistical methods have been used to evaluate water quality series.

In addition developing new statistical approaches is an essential part of understanding climate and its impact on society in the presence of uncertainty. Experience has shown that rapid progress can be made when "big data" is used with statistics to derive new technologies (11).

Modern statistical methods have the ability to propagate the uncertainty generated by different sources of information. Because of a tradition rooted in the hydrological and engineering sciences, water managers have a vast array of experiences, methods, and tools with which to address environmental and quantifiable uncertainties. It is therefore that water management need to take these uncertainties into account (5).

But it is unfortunate that the knowledge and methods needed to address uncertainties in learning and decision-making processes are largely lacking. The best-known type of uncertainty is a lack of knowledge because of the limited availability and the variability of data. Quite a few technical approaches exist to include such uncertainties in simulation models. Uncertainties may be captured by including uncertainty bounds in results from model simulations or other types of quantitative assessments.

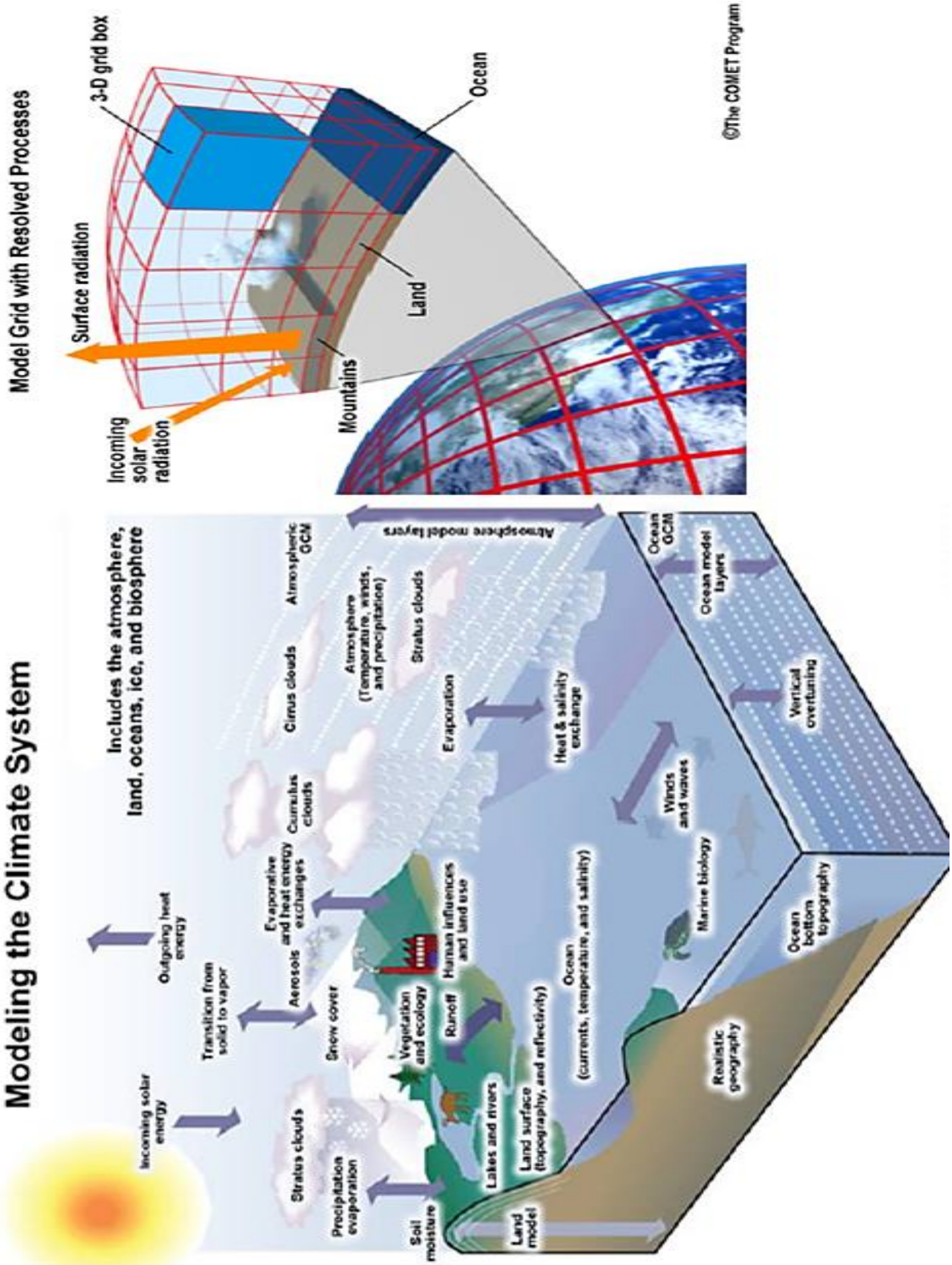

Figure 2. Modelling the Climate System

2. 2. Can full cost recovery be a protection measure itself through water pricing

2. 2. 1. Full Cost Recovery

For the past two decades, new and more integrated approaches to water management have been developed and are being implemented to address perceived shortcomings in earlier approaches. During the last decade, the principle of integrated water resources management (IWRM) has been used as a framework for the implementation of such integrated approaches to water management. In this framework the principle of full cost recovery has been accepted as a financially sustainable and environmental approach.

The principle of Full Cost Recovery (FCR) is about the amount of money that is being paid for not only to the financial costs of the provision of water services, but also to the costs of associated negative environmental effects (environmental costs) as well as forgone opportunities of alternative water uses (resource costs).

Calculating a price that reflects the true value of water, and thereby contributing to the long-term sustainable management of water resources, is clearly not a simple task. However, it is critical, for both the effectiveness and the integrity of the proposed water pricing systems. Full Cost Recovery is considered an option for handling increasing water scarcity and all of its effects, including environmental and human effects. This principle is described in a review of water pricing in the European Union (EU) carried out by the European Environmental Bureau (EEB) (14).

Cost Recovery would include consideration of all of the following:

- *Operational and maintenance costs;*
- *Capital costs;*
- *Opportunity costs;*
- *Resource costs;*
- *Social costs;*
- *Environmental damage costs, and*
- *Long run marginal costs.*

Integrating social and environmental costs in an FCR framework would involve making a certain quantity to every person and employing the Polluter Pays Principle (PPP). The PPP, in which those creating pollution have to pay the entire environmental cost, internalizes those environmental damages, rather leaving environmental costs as externalities where the public ends up paying the cost (with health care bills or otherwise).

The basic premise of FCR is that the representation of the true cost of water in all sectors will cause users to value at its real cost and will help the allocate water to where it is most valued. The European Environmental Bureau recognizes that FCR is a lofty goal, and will be difficult to achieve fully. However, they list recommended elements to move toward it. (Roth, 2001) The European Environment Agency (EEA) also has produced a series of reports that assess the state of Europe's waters and future challenges.

2. 2. 2. Full Cost Recovery Implementation in EU and Results

One of the study completed in 2013 (3) found a varying degree of cost recovery between EU Member States and between water-use sectors. The report indicates that (EEA 2013) While operation and maintenance costs are recovered from water users in most countries and sectors (excepting some gravity irrigation systems in southern EU Member States), this is generally not the case for investment costs, including drinking water and sewage services. In several EU Member States, uncertainty remains concerning possible hidden subsidies linked to preferential access to financial resources given to water service operators. With regard to environmental and resource costs, existing abstraction and pollution charges (including taxes) are mechanisms that can help internalize these costs. But their relative low levels makes it unlikely that they can recover any (fair) share of environmental and resource costs. States), this is generally not the case for investment costs, including drinking water and sewage services (3).

In the report (EEA 2013) it is pointed out that " the Water Framework Directive did not result in a change in water pricing policy, EU Member states efforts being mostly limited to (cost recovery) assessments and to reporting to the European Community. In selected EU member states changes in water pricing have been implemented in recent years (the Netherlands and Spain), or will shortly be put into effect (Ireland). But these changes were largely policy responses to the current economic and financial crisis, in some cases actually contradicting the principles promoted by the WFD.

The studies showed that there is a lack of harmonized and operational concepts of cost recovery, and environmental and resource costs including inventiveness in EU.

It is worth noting that the European Commission still needs to put together an official interpretation of environmental and resource costs; therefore it is impossible to conclude at this stage if current efforts by EU member states to comply with the cost recovery principle will suffice. Nevertheless, there are some elements of the cost recovery provision that the European Commission is starting to evaluate (3).

2. 2. 3. Barriers to Water Full Cost-Recovery Pricing

The process of implementation of cost recovery driven by the WFD has had numerous obstacles of various natures. A study of individual EU Member States reveals that such obstacles are commonly related to the specific context of the country in question, and a complex array of factors ranging from cultural traits to socio-economic aspects play a part in the mix.

One of the barrier identified in the report ((3) was resistance from stakeholders and users to the rise in water prices. The general perception that household water demand is inelastic with respect to pricing and the notion that water is a basic requirement for life (and so an arbitrary rise in the price of this basic good is socially unjust) both pose uncomfortable political hurdles to the establishment of the cost-recovery principle forwarded by the Water Framework Directive.

3. PRESURES ON SUSTAINABLE WATER ECONOMICS

The world's growing population is needed to be adequately feed and support. To be able to do that the global economy needs to continue to grow. This shows that water resources will play a critical role to future growth. But it can also become the major limiting factor to growth. For instance, businesses in water-scarce areas are already at risk, and so during their decision-making processes.

Rapid development in related science and technolgy and experience gained in efficiency and productivity in water management and utilization can reduce these risks. But because of the dynamic characteristics of water demand and climate change effects there are still several uncertainties to be studied on

In order to make water management dynamics clearer we should examine current demand and supply pressures and look at trends within each. Demand pressures include population growth and an increase in water-intensive diets as a portion of the population moves into increasingly higher water-consumption behaviors. Demand pressures also include growing urban, domestic and industrial water usage. Climate change plays a role by creating additional water demand for agriculture and for reservoir replenishment. On the supply side, issues such as water transport, availability and variability present challenges, as does the decline in renewable water resources (17).

Examining carefully we can see that every one of these categories, trends are moving in the exact opposite direction necessary to sustain future growth. Taken together, these trends create "water stress." And the resulting ecosystem pressures along with economic and political conflict only exacerbate that stress (17).

Today, many regions of the world are already water stressed due to population and economic growth. In fact, 2.5 billion people (36% of the world population) live in these regions and more than 20% of the global GDP is already produced in risky, water-scarce areas affecting production, as well as corporate reputations when competition over water usages develops.

4. CONCLUSIONS

Hydro economics will play more important role in sustainable water management under the effect of climate change and rising poverty in coming decades. Water is linked with the climate system and thus with climate change. Therefore climate change as an added dimension of the sustainable water management that considers both ecosystem protection as well as access to water as a human right, will bring more uncertainty and risk to water managers and decision makers. Because of that water economics has to move in parallel and incorporate such considerations.

Water economists should get involved, and this involvement could lead to the adoption of better-informed climate change mitigation and adaptation strategies (13)
Climate change related water availability changes affect various economic sectors differently. One modeling study finds that for every 1 °C increase in temperature, 7% of the global population is expected to experience a decline in freshwater resources of at least 20% (13).

Most impacts will affect poorer countries disproportionately. Poorer countries also tend to have less financial and other capacities to address, combat, or avoid adverse climate change impacts. (This is especially true for countries where agriculture is dominated by low-income farmers practicing dryland agriculture.) (13) .

While successive IPCC reports have worked toward reducing uncertainty, key impacts — such as the impact of changing climate variability on key economic variables and outcomes — have yet to be assessed. Addressing uncertainty in this sphere remains challenging — requiring sensitivity analyses and the use of probability density functions and other statistical approaches — and even then it will be difficult to present a full picture of complex climate - change – water interactions (13).

We need to understand the economics behind climate-smart investment options for water.it is also essential to understand who benefits and who loses under alternative investment pathways and priorities. This means taking equity and environmental considerations into account, and going beyond traditional economic assessment approaches.

The field of climate change–water assessments remains challenging, and it opens the door for many future enthusiastic water economists. But it will be essential for economists in this field to work with climate scientists, ecologists, agronomists, geographers and other scientists. Complex interactions between water and climate needs multi dimensional research collaboration on the costs and benefits of both adaptation and mitigation options.

Economic analysis should also consider how policy can contribute to cost- effective adaptation. Economic development, combined with social protection systems, continues to enable poor people to escape poverty and malnutrition. It is therefore that this remains an important complementary water economics strategy to water–climate change investments and water pricing methods. Water Economists need to contribute to applicable assessments. It is time for water economists working on climate change and full cost recovery approach.

If one can't create more appropriate water economics concept for current price mechanism, water price will be heavily increased by adding resource costs, environmental costs etc. in full cost recovery approach resulting in considerable negative effects on low level economic income society.

This can in turn led to severe impacts on the increasing manufactured prices related to water use. It is therefore that a sustainable hydro economics will play very important role the future of the world.

In fact the water economics is not only a matter of affordable price for drinkable water but also establishing an economical-environmental-social balance that protects water resources. Because most of the people are not realizing the water shortage as long they can pay the price of the water. This is hiding the risk drivers so that they may never get up to know how to make to change their behaviors toward the water resources.

We should be aware of that tomorrow's challenges are already at our door in terms of sustainable water management as well as sustainable water economics. It indicates that water governance and financing models are required to implement change.

Analysis by the International Food Policy Research Institute (IFPRI), shows that "4.8 billion people – more than half the world's population – and approximately half of global grain production will be at risk due to water stress by 2050 if status quo, business-as-usual behavior is followed". The IFPRI study also found that 45% of total GDP ($63 trillion) will be at risk due to water stress by 2050. That's 1.5 times the size of today's entire global economy.

This growing disasters shows that water issues need a paradigm shift and more applicable solutions than before. We should waste less, pollute less, reuse more, manage effectively and become more efficient in all uses of water to achieve higher water productivity levels and reduce water stress.

Continued evolution of technology and infrastructure improvements will enhance water supply capacity for cities and industries. But it is also important to achieve a sustainable water economics to supply enough and clean drinking water and sanitation services to everybody with affordable price. If we can't achieve changing today's approach to future sustainable water- economics management, not only 1 billion people and about $17 trillion in GDP will be at risk but also regional peace and stability will be at risk of unsustainable water supplies by 2050

What is more, if climate change reduces water availability, it will result in higher food prices, and the combined effect of higher prices and demand of water will result in significant increases in household expenditures. This decreasing living standards can force social fluctuations like situation in Syria and Iraq.

In developing countries, improved access to water supply and sanitation services has been an important component of their overall development plan. However gained experiences showed that achievement of the desired impact cannot occur without critical sectoral reforms. A key constraint in the implementation of sectoral reforms has been inadequate attention to developing appropriate incentives and financing mechanisms.

Therefore, water economics need further research based on an identification of issues in the use of different sets of finance mechanisms, as well as the possible variations in their use in different contexts. It should provide appropriate financing mechanisms and support for appropriate sectoral reforms to ensure long-term sustainability of water management as well as improving utilization" water for all" approach.

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