Impact of Climate Change on Worlds Economy and Hydrological System

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Authors’ contributions

This work was carried out in collaboration and combined efforts of both authors. Authors SA and IJ has collectively designed the study, performed the statistical analysis, wrote the protocol, the first draft of the manuscript, jointly managed the analyses of the study and literature searches. Both authors read and approved the final manuscript.

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ABSTRACT

The Mediterranean region appears to be particularly responsive to global and climate change. The global mean temperature has increased by 0.8°C compared with preindustrial levels while Europe has warmed more than the global average, especially in the Mediterranean, the north-east region, and mountain areas. Increasingly drier conditions are observed in the Mediterranean region both in the wet and in the dry season (~20%) with an increasingly irregular precipitation in both seasons (~40% in the dry season). The annual river flows have also decreased in the Mediterranean region, a difference projected to exacerbate due to climate and global change, which made the Mediterranean region most prone to an increase in drought hazard and water stress. Iberian Peninsula has been already affected by several major droughts, e.g. the recent one in 2005. These driving forces of global change impacts on water availability, water quality, and ecosystem services in Mediterranean river basins of the Iberian Peninsula, as well as their impacts on the human society and economy, makes it an important issue on the EU agenda. This thesis is an approach to quantify and analyze the water quantity, hydrological ecosystem services, and water supply in

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1. INTRODUCTION

Climate change has become an established reality with no borders and respect for mankind globally. There are shifting patterns of climate affecting many sectors of the economy either directly or indirectly. The world has already witnessed the year 2016 as the warmest, since the birth of planet earth. Besides, glaciers on the Northern Arctic have changed a great deal which can be evidenced by changes in their contour and magnitude coupled with near-future predictions of breaking of gigantic glacial masses from the main body of ice. Arctic ice is melting at an amazing speed due to incremental summer temperature [1].

Unlike the weather, which is a short-term change in atmospheric condition, climate is referred to as a long-run atmospheric state that persists for several years, decades, or even centuries in a continuous pattern. The temporal breadth and spatial width are important imperatives for climate change amidst microclimate variations and extreme weather events. Intergovernmental Panel on Climate Change (IPCC) claims, climate change is due to natural or anthropogenic activities and this change remains for a long time. The implicit and explicit derivatives of these natural and anthropogenic activities may also be included in the overall connotation of climate change. Similarly, United Nations Framework for Convention on Climate Change defines climate change as the change in the weather for a prolonged time, caused directly or indirectly by activities of humans that have brought variations in the configuration of the global atmosphere. This suggests that all layers of the atmosphere are part of climatic studies [2].

The chief objective of the paper is to explore, analyze, and estimate the retrogressive change the world economy and global water cycle are experiencing owing to the existential threat of climate change. The authors have analyzed various reputed research forums, publications & findings to estimate and substantiate the views and dimensions the paper is focusing on.

2. LITERATURE REVIEW

Climate change is the mother of all externalities, larger, more complex, and more uncertain than any other environmental problem. Sulfur dioxide emissions, one of the main causes of acidification, arise from impurities in fossil fuels. Sulfur is a nuisance as well as an externality. However, thermal energy is generated by breaking the chemical bonds in carbohydrates (e.g., oil) and oxidizing the components to CO2 and H2O. That is, CO2 is intrinsic to fossil fuel combustion. Climate change is therefore not just an efficiency problem, but also an equity problem. As the status quo is an unjust externality, the Co-Asian separation of equity and efficiency has little practical value. Climate change is also a long-term problem. Some greenhouse gases have an atmospheric lifetime of tens of thousands of years, and a small part of carbon dioxide will stay in the atmosphere practically forever. Greenhouse gas emissions are in this sense comparable to nuclear waste, but the quantities are too large to permit the containment approach that is used to store radioactive material. Finally, the uncertainties about climate change are vast – indeed so vast that the standard tools of decision-making under uncertainty and learning may not be applicable. As all these issues come together in the emission of greenhouse gases, climate change truly is one of the greatest intellectual challenges of our times [3].

Atmospheric warming and other consequences of climate change have a direct impact on those systems where optimum functioning relies greatly on climatic parameters. More precisely, slight variation in climate will have a direct impact on climate-sensitive systems (CSS) mainly agriculture and allied sectors especially livestock, forestry, and other natural resources. Similarly, the contribution of the agronomy and livestock sector to climate change has gained much attention in the past few years. The ensued impact is the pervasive community as well as industry interest in evaluating the life cycle of foodstuffs for humans concerning GHG emissions. For the agriculture and livestock

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sector, changing climate will affect the yield of crops, meat, and dairy product. These also cause economic effects in terms of price of products (agriconomic and dairy), their demand, regional and international trade, comparative advantage, and producer/consumer welfare. Net agronomic, dairy, and economic impacts will depend primarily on the magnitude of climatic change and locale precise capacity to captivate the outcome of climate change [4].

The direct impacts of climate change on the livestock sector include high temperature and erratic rainfall patterns. These factors will be translated into the amplified spread of macroparasites and current vector-borne diseases, supplemented by the appearance of new diseases. Few areas may witness new transmission models of the diseases due to changing climate. The indirect effects may include variations in feed resources related to the carrying capacity of rangelands, intensified desertification processes, buffering abilities of ecosystems, augmented scarcity of water assets, and reduced yield. Moreover, expected shortage of feed for livestock is also in sight due to competitive demand for food, feed and fuel production, and also the land-use systems [5].

Climate is expected to continue to change in the future despite there are still many uncertainties, which will affect natural and human systems such as forestry, fisheries, water resources, human settlements, and human health. The global surface temperature has risen by 0.74 °C in the past 100 years, with temperatures increasing more rapidly in the past 50 years. Heat and water are closely linked, and in recent decades, warming trends have led to changes in the hydrologic cycle (Intergovernmental Panel on Climate Change (IPCC, 2007)). Disturbances in the hydrological cycle can cause water scarcity in a region. Water scarcity refers to the relative shortage of water in a water supply system that may lead to restrictions on consumption. Scarcity is the extent to which demand exceeds the available resources and can be caused either by drought or by human actions such as population growth, water misuse, and inequitable access to resources. Most of the Mediterranean countries are facing water scarcity. Whereas, drought is a recurrent feature of climate that is characterized by temporary water shortages relative to normal supply, over an extended period, a season, a year, or several years. The term is relative since droughts differ in extent, duration, and intensity [6].

According to the World Resources Institute (WRI), the world’s water systems face formidable threats. More than a billion people currently live in water-scarce regions, and as many as 3.5 billion could experience water scarcity by 2025. Increasing pollution degrades freshwater and coastal aquatic ecosystems. And climate change is poised to shift precipitation patterns and speed glacial melt, altering water supplies and intensifying floods and drought in different parts of the world [7].

Changing climate has a momentous influence on irrigated agriculture. Increased level of irrigation has proved to be a strong driver of mitigation technique to withstand the climate change impacts such as land degradation issues and evapotranspiration. By increasing the supply of irrigation water, crops can cope with high-temperature stress. However, most of the countries in the world have Arid to Semi-Arid climate which is marked with less supply of 18 water and is warmer. Similarly, the water resources are also depleting. Salinity is another factor playing its role in damaging the land available for production. Studies have shown that an increase in water supply for irrigation can be helpful to withstand salinity as an excess supply of water leaches down additional salts deep down into the soil. This demands an optimistic approach for the usage of irrigation water [8].

The water scarcity has also affected some temperate regions with normally plentiful resources, such as Europe and North America, where periods of drought are becoming more frequent and are lasting longer. Due to successive droughts over the last decades, some watercourses have dried up and the level of groundwater supplies has reached in many parts of Italy, France, Spain, and the UK. Europe’s waters are affected by several pressures, including water pollution, water scarcity, and floods. Major modifications to water bodies also affect morphology and water flow. The Mediterranean region is undergoing rapid local and global social and environmental changes [9].

All indicators point to an increase in environmental and water scarcity problems with negative implications for current and future sustainability. The water scarcity pressures are not homogeneous across the Mediterranean region and sectors of water use. The risk of water scarcity is proposed to manage by preparedness rather than a crisis approach along with the importance of local management at the
basin scale. Climate change increases water resource stresses in some parts of the world where runoff decreases, including around the Mediterranean, in parts of Europe, central and southern America, and southern Africa. In other water-stressed parts of the world, particularly in southern and eastern Asia, climate change increases runoff, but this may not be very beneficial in practice because the increases tend to come during the wet season and the extra water may not be available during the dry season. Future population growth will increase the pressure on available water resources in many countries as well as globally. How countries around the world manage water resources is becoming more critical with each passing day. And climate change is likely to play havoc with even the best-laid management plans (Smakhtin, 2010).

Climate change will increase water temperature and the likelihood of flooding, droughts, and water scarcity in the years to come. There are many indications that water bodies already under stress from pressures are highly susceptible to climate change impacts, and that climate change may hinder attempts to restore some water bodies to good status. Preparing for climate change is a major challenge for water management in Europe. The Water Framework Directives (WFD) is the first piece of European environmental legislation that addresses hydro morphological pressures and impacts on water bodies. It requires action in those cases where the hydro morphological pressures affect the ecological status, interfering with the ability to achieve the WFD objectives [10].

2.1 Estimates of the Total Impact of Climate Change

The first studies of the welfare impacts of climate change were done for the USA. Most fields are dominated by a few people and fewer schools, but dominance in this field is for the want of challengers. The impact of this is unknown, but this insider argues below that the field suffers from tunnel-vision. This situation is worrying. Politicians proclaim that climate change is the greatest challenge of this century. Billions of dollars have been spent on studying the problem and its solutions, and hundreds of billions may be spent on emission reduction. Yet, the economics profession has essentially closed its eyes to the question of whether this expenditure is justified [11].

Carbon dioxide in the atmosphere reduces water stress in plants and may make them grow faster. Another reason is that the global economy is concentrated in the temperate zone, where warming reduces heating costs and cold-related health problems. At the same time, the world population is concentrated in the tropics, where the impacts of initial climate change are probably negative. Even if, initially, economic impacts may well be positive, it does not follow that greenhouse gas emissions should be subsidized as the climate responds rather slowly to changes in emissions. The initial impacts cannot be avoided; they are sunk benefits. Impacts start falling at roughly the same time emission control affects climate change. The fitted line suggests that the turning point is at 1.1ºC warming, with a standard deviation of 0.6 ºC. Even though the total impacts of 1-2ºC warming may be positive compared to today, incremental impacts are negative [10].

2.2 Research Needs

The literature reviewed above is largely limited to estimates of the direct costs, that is price times quantity, with constant prices. This is a crude approximation of the welfare impact. General equilibrium studies of the effect of climate change on agriculture have a long history. These papers show that markets matter, and may even reverse the sign of the initial impact estimate show that sea-level rise would change production and consumption in countries that are not directly affected. Ignoring the general equilibrium effects leads to a small negative bias in the global welfare loss, but differences in regional welfare losses are much greater and may be negative as well as positive. Similarly, Bosello et al. (2006) show that the direct costs are biased towards zero for health, while Berrittella et al. (2006) emphasize the redistribution of impacts on tourism through markets. More research along these lines is needed.

A cross-sectional analysis of per capita income and temperature may suggest that people are poor because of the climate. This would, wrongly, suggest that warming could cause economies to shrink or grow slower. This would increase the damages of climate change. As poverty implies higher impacts, this would drag the economy down further. However, as shown in Fankhauser and Tol (2005), only very extreme parameter choices would imply such a scenario. This is in sharp contrast to the econometric results of Dell et al. (2008), who find conclude
that climate change would slow the annual growth rate of poor countries by 0.6 to 2.9 percent points. Accumulated over a century, this effect would dominate all earlier impact estimates. Unfortunately, Dell et al. (2008) have only a few explanatory variables in their regression, so their climate effect may suffer from missing variable bias. Gallup et al. (1999) and Masters and McMillan (2001) find a relationship between geography and development, but Easterly and Levine (2003) show that the results are not robust and that institutions are a better explanation of income difference than is geography and climate. Acemoglu et al. (2002) reach the same conclusion. However, Acemoglu et al, argue for climate as a root cause of development, via the route of the mortality of European settlers. Future climate change will not affect history, though. Demo-economic models also put mortality center stage. In their models, the difference between Malthusian stagnation and exponential growth is determined by the quality-quantity trade-off for children, which is partly driven by infant mortality. A risk-averse parent would opt for more children, to increase the chance of old-age care; a large number of inadvertently surviving children would reduce the money spent on their education. These children would become poor adults, unable to afford health care for their offspring. Should climate change increase the prevalence of malaria and diarrhea, then the poverty trap would widen.

### 2.3 Missing Impacts

The impacts of climate change that have been quantified and monetized include the impacts on agriculture and forestry, water resources, coastal zones, energy consumption, air quality, and human health. This list is incomplete. Also within each impact category, the assessment is incomplete. Studies of the impacts of sea-level rise on coastal zones, for instance, typically omit saltwater intrusion in groundwater. Furthermore, studies typically compare the situations before and after climate change but ignores that there will be a substantial period during which adaptation is suboptimal, the costs of this are not known. Some of the missing impacts are most likely negative. Increasing water temperatures would increase the costs of cooling power plants. Redesigning urban water management systems be it for more or less water, would be costly, as would implementing the safeguards against the increased uncertainty about future circumstances. This is true for other infrastructure as well. Extra tropical storms may increase, leading to greater damage and higher building standards. Tropical storms do more damage, but it is not known how climate change would alter the frequency, intensity, and spread of tropical storms. Ocean acidification may well harm fisheries. These matters are relatively small compared to overall economic activity. Even if climate change would double or triple the cost, the impact would be small. Other missing impacts are probably positive.

Higher wind speeds in the mid-latitudes would decrease the costs of wind and wave energy. Less sea ice would improve the accessibility of arctic harbors, would reduce the costs of exploitation of oil and minerals in the Arctic, and may even open up new transport routes between Europe and East Asia. Warmer weather would reduce expenditures on clothing and food, and traffic disruptions due to snow and ice. Also in these cases, the impact of climate change is likely to be small relative to the economy.

### 2.4 Welfare

It is beyond doubt a multidisciplinary & multifaceted research findings and data are direly needed to make sense of and grasp an all-encompassing impact assessment of the changing climate patterns. The missing information warrants extensive research focused on all subject areas & disciplines the climate change has touched upon. The information gaps described above require research that combines economics with other disciplines. Two issues are pure economics. Both have to do with the specification of the welfare function. The impacts of climate change are uncertain, but will likely fall heaviest on poorer countries. In textbook economics, attitudes towards uncertainty are measured by the rate of risk aversion, or the elasticity of marginal utility for consumption. The same parameter plays an important role in the Ramsey discount rate, as it also partly governs the substitution of future and present consumption. Furthermore, this parameter drives the trade-offs between differential impacts across the income distribution, both within and between countries. The consumption elasticity of marginal utility thus plays four roles. Although conceptually distinct, all climate policy analyses that I am aware of use a single numerical value. The reason for this is simple. It is well known that consumption smoothing over time and risk aversion are different things, and different again
from inequity aversion – and that attitudes towards income gaps are differences within and between jurisdictions.

Despite considerable research, welfare theorists have yet to find welfare and utility functions that make the necessary distinctions and can be used in applied work. Climate change adds urgency to solving the theoretical problems. There is a similar problem with the population. Standard welfare functions work fine if population growth is exogenous, but produce peculiar and undesirable results if the population is endogenous.

3. CONCLUSION

This study shows that, an approach to quantify and analyze the water quantity, hydrological ecosystem services, and water supply in temperate regions under environmental changes. A hydrological model is developed for a low flow Mediterranean river (Francoli River) to assess the water allocation situation in the river basin using MIKE BASIN. Since the Mediterranean regions are hard hit by the changes in the global climatic patterns, the hydrological model focuses on the water distribution system & flow in the region.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

RELEVANT REFERENCES

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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