CLIMATE CHANGE IMPACTS ON DAMS PROJECTS IN TRANSBOUNDARY RIVER BASINS. THE CASE OF MESTA/NESTOS RIVER BASIN, GREECE

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The construction of big projects, such as a large dam, engages the careful consideration of all the relevant parameters for two fundamental reasons. Firstly, because a dam is considered to be an “installation containing dangerous forces” due to the massive possible impact on the civilian population and the environment in case of unexpected accidents. It is therefore governed by the rules of International Humanitarian Law (IHL) [5]. Secondly, from an economic point of view, a dam is considered to be a huge investment, running the risk of failure and of not being operational.

This is the reason why a dam’s or more specifically a hydropower plant’s construction study should be coupled with an economic and operational study. On the one hand the construction study should take into account the dam’s purpose, the location and its physical characteristics, the construction technique and materials, and the environmental impacts according to the international and national legislation. On the other hand, the economic and operational study should take into account all the variables which ensure the feasibility of the project. However, since the fuel of a hydropower plant is water, the management of its water resources is essential for the optimisation of the plant’s operation in order to meet power and water demands while increasing overall operating efficiency [10].

Until a few years ago, the vast majority of dams were funded and consequently owned by the public sector, which was represented by the public power utility or, to a lesser extent, the public agency responsible for irrigation development. Thus, the project profitability was not the greatest priority issue, meaning that sometimes the energy production profit was sacrificed for socially justified reasons [6]. For instance, less energy production serves to fulfill augmented demands of water for irrigation purposes. Nevertheless, the liberalisation of the electricity market in the developed world has led to the privatisation of infrastructure development and has set new standards in the funding and management of dams’ projects.

In order for dams projects to be financed by the private sector they should encompass multipurpose uses, i.e., coupling of electricity generation with irrigation and water supply potentials. The other uses of a dam, such as flood control, recreation and inland navigation, tend to be secondary uses which fall within the “non-commercial” category as far the project financing is concerned, although these uses may increase the total economic benefits of a dam project [2]. Nevertheless, the current prices of oil, hence the prices of electricity, are at extremely high levels. Consequently, hydropower plants projects can be justified as the sole reason for funding, since the profitability of the generated electricity covers the investment capital cost.

On the other hand, there are some external factors which act dissuasively in attracting financing from the private sector. A large dam can exercise control over the downstream area since it regulates the downstream flow and water availability for at least 25 years, which is the dam’s operational life time. This is the period for which all the economic evaluations for the project viability and profitability i.e. NPV and IRR have been based. However, for such a long period, potential water management conflicts may occur, i.e. a balancing agreement between the different water users is complicated and difficult to be achieved. Additionally, even in cases of excess water availability, governments hesitate to commit themselves to the

investors' long term agreements, especially now that there is great uncertainty about the impact of climate change.
As the climate change is concerned, the climate change scenarios which were developed by the Intergovernmental Panel of Climate Change (IPCC) with the publication of the Special Report on Emissions Scenarios (SRES) [3] revealed great climate variations at global scale. More specifically, according to the output of the General Circulation Models (GCM) the global averaged surface temperature is predicted to be increased by 1.4 to 5.8°C over the period 1990 to 2100. Temperature increases will also result to evaporation rate increases and to precipitation fluctuations. Consequently, one of the sections influenced by the climate variations is the renewable technologies which completely rely on the climate conditions. Moreover, the largest impact may be on hydropower generation as it is sensitive to the amount, timing, and geographical pattern of precipitation as well as temperature [1].

The purpose of this paper is to examine the climate change impacts on existing and future dams' projects on the Mesta/Nestos River Basin. Mesta/Nestos River basin is a transboundary river basin in South Eastern Europe (SEE), almost equally shared between Bulgaria, upstream country, and Greece, downstream country. The basin orientates from the North (where the headwaters are located) to the South East (river outlet). The river before discharging into the Aegean Sea forms the Nestos delta which is a highly cultivated area with great importance to regional and national economy. The past estimated mean runoff, 1965-1990, of the Mesta/Nestos River is 20 to 30 m^3/s, the maximum discharge was rarely above 150 m^3/s while the minimum flow was often lower than 10 m^3/s and the annual discharge 1,120 M m^3 [8][9].

Currently in the greek part of the basin there are three hydroelectric power plants. Two are located in the mountainous part of the basin: the upstream dam of Thissavros and the downstream dam of Platanovryssi. The reservoir of Thissavros dam has a surface area of 18 Km^2 and stores $565*10^6$ m^3 of water and the reservoir of Platanovryssi has a surface area of 3.25 Km^2 and stores $11*10^6$ m^3 of water. The installed capacity of the Thissavros dam is 384 MW and the annually electricity generation in 2005 was $440*10^6*$kWh, while the installed capacity of the Platanovryssi dam is 116 MW and the annually electricity generation in 2005 was $240*10^6*$kWh [4]. The third dam, namely Toxotes, which is mainly a regulatory dam, is located in the delta's neck in order to divert the water to the plains of Kavala (western part of the delta) and Xanthi (eastern part of the delta) through two main channels. Furthermore, the construction of a new dam downstream of the Platanovryssi dam, both for electricity production and irrigation purposes, is in the tender procedure. The future dam, namely Temenos, is planned to have a surface of 1.05 Km^2 and to store $6*10^6$ m^3 of water. The potential electricity generation is estimated to be $62*10^6*$kWh with power capacity of 15 MW.

For the needs of our work two different downscaling techniques were applied in order to use the results of GCMs. Firstly, a statistical method based on regression techniques was implemented to downscale the results of two Atmospheric-Ocean GCMs (AOGCMs) in our region extend. More particularly, the precipitation results of the SRES A2 scenario produced by the coupled model ECHAM4/OPYC3, and the coupled model ECHAM5/MPIOM, both developed by the Max Planck Institute for Meteorology, Germany, have been downscaled in order to be used for climate change predictions. Secondly, a dynamically downscaling technique was implemented for obtaining future regional climate conditions. More particular the regional climate model CLM whose boundaries conditions were provided by the coupled model ECHAM5/MPIOM, developed by Max Planck Institute for Meteorology, was used for the SRES scenarios A1B and B1.

The Mesta/Nestos basin is a region of developing potential and has many similarities with the status described by the A1B and B1 scenarios. According to demographic statistics, both the Bulgarian part and the Greek part of the basin present population augmentation, such as in A1B and B1 scenarios. Economic indicators reveal that both parts of the basin present economic growth. In the Bulgarian part, apart from the EU funds designated to ameliorate the region's infrastructure, a big number of investments in tourism helps the local economy. In the Greek part of the basin, a number of private and public investments and the further exploitation of the agricultural potential of the region, indicates the region's prosperity. On the other hand, both Bulgaria and Greece as EU members are obliged to environmental protection policies such as the Kyoto protocol and the European Union target to cover the 20.1% of the corresponding electricity consumption from renewable resources by 2010. Thus, the introduction of clean and resource-efficient technologies which is presented in A1B and B1 scenarios is also going to be adopted by both countries. As for the A2 scenario which describes a very pessimist future evolution, it has been used in order to evaluate the impacts in the Mesta/Nestos region under extreme conditions.

The precipitation and temperature results obtained from the CLM model were then used as input data to the spatially distributed hydrologic model MODCOU [7] for simulating the basin's future runoff. The dams' simulation was conducted with the HEC-ResSim (U.S. Army Corp of Engineers Hydrologic Engineering Center-Reservoir Simulation) tool by taking into account the outputs of the hydrologic model. The water volume stored in the reservoir, the dam water discharge and the produced electricity was then evaluated for both the Thissavros and Temenos dam.

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