Impact of Climate Change on Water Resources Management in Sri Lanka

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INTRODUCTION

About 75 per cent of the world's population lives in areas which have been affected by various disasters at least once during the last two decades. Throughout history there have been sudden, terrible events that have shaken the world. A disaster is the impact of a natural or human-made hazard that negatively affects society or environment and mainly water resources. Developing countries suffer the greatest costs when a disaster hits more than 95 percent of all deaths caused by disasters occur in developing countries, and losses due to natural disasters are 20 times greater (as a percentage of GDP) in developing countries than in industrialized countries.

Sri Lanka is an island in the Indian Ocean and located south of the Indian subcontinent (65,610 sq.km in extent) with a central hill country surrounded by coastal lowlands. Nearly 75% of the land is flat or undulating. Rivers (103) and numerous streams radiate from the central highlands. Sri Lanka has a warm climate, moderated by ocean winds and considerable moisture. However this island has highly varying climatic conditions within it based on the rainfall patterns and the monsoonal rains which bring rains to the island. Based on the rainfall the country is demarcated mainly in to three zones name: dry, intermediate and wet zones (Figure 1). In addition the country is demarcated in three mainly on elevation namely up country (>1000m masl), mid country (300-1000 masl) and low country (<300masl).

Global climate change will have varying impact and within a small island like Sri Lanka the impacts of climate change will be variable from region to region. Therefore this paper is intended to study the spatial impacts of climate change on climatic factors which contributes to the water resources management such as rainfall, temperature, soil moisture deficits and surface runoff. It also highlights the systematic planning of adaptation measures that would enhance better water resources management of the people in different agro-ecological regions to cope with longer term climate change and its associated insecurities.

Background of the Research Study

In this work the HadCM3 which is a coupled atmosphere- ocean general circulation model (AOGCM) developed at the Hadley Centre for Climate Prediction and Research (United Kingdom) has been used. This model has a spatial resolution of 2.5 x 3.75 (latitude by longitude).

HadCM3 provide information about climate change in all over the world during 21[st] century and provide information about three times slices: 2020s, 2050s, and 2080s. In order to provide information on possible changes in the world climate, the climate change models are forced to consider future scenarios. In this study Intergovernmental Panel of Climate Change (IPCC) Special Report on Emission Scenarios (SRES) scenarios were considered.

The four SRES scenarios combine two sets of divergent tendencies: one set varying between strong economic values and strong environmental values, the other set between increasing globalization and increasing regionalization. In this work the two scenarios have been considered: A2 as the worst scenario and B2 as the second worst scenario. The percentages of change predicted by the HadCM3 model must be applied to a baseline. As the resolution of the HadCM3 model is too big, simple interpolation technique (kringing) was used and climate change projections were applied to a baseline climatology dataset developed by the International Water Management Institute (IWMI). This baseline dataset is a 10 minute latitude/longitude (approximately 20km x 20km resolution) grid dataset for a period of 1961-1990. Different statistical transformations exist for this downscaling future temperature and rainfall. Here it followed the generally accepted downscaling technique. Evapotranspiration was estimated using Penman-Monteith formula. Soil moisture deficit was estimated using simple water balance method. Runoff is estimated based on runoff coefficients with rainfall intensity and soil moisture deficit.

A geographical information system(GIS) has been used to integrate the climate data (mean monthly) to generate maps showing the spatial The attribute value of each data set of each grid pixel was appended to each centriod. A contouring function was used to generate the point data set into a surface, by applying a ordinary Kringing method in geo statistical analysis.

FINDINGS

Rainfall

In Colombo and Galle the average annual rainfall in is predicted to increase by 32% (A2) and 24% (B2) compared to the baseline (1961-1990). In Kandy, Nuwara Eliya and Ratnapura the average annual rainfall is predicted to increase by 12% (A2) 5 % (B2). However the rainfall is predicted to decrease in other dry zone areas such as Vavuniya, Anuradhapura, Batticaloa and Trincomalee. Among the dry zone areas the highest decrease is predicted in Batticaloa 14% (A2) and 12% (B2) scenarios.

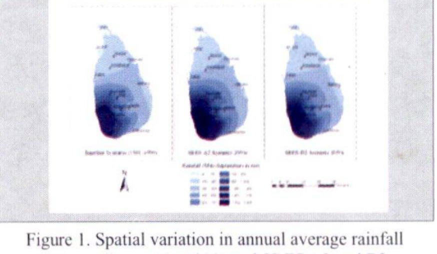

Figure 1. Spatial variation in annual average rainfall for baseline (1961-1990) and SRES A2 and B2 scenarios for 2050s. Source: De Silva et al (2006)

Southwest Monsoon Rainfall across the country is predicted to increase by 38% (A2) and 16% (B2) in 2050s (Figure 3). Colombo, Ratnapura, Galle and Nuwara Eliya the rainfall during May to September is predicted to increase by 43%-57% (A2) and 19%-27% (B2). This increase in rainfall will cause floods and land slides in wet zone areas (De Silva et al, 2007). **Northeast Monsoon Rainfall** (December to February) is predicted to decrease 34% (A2) and 26 % (B2) in 2050s (De Silva et al, 2007). The highest decrease is predicted in Trincomalee and Batticaloa 27% (A2) and 29 %(B2).

Annual Average Temperature

The average annual temperature is predicted to increase by 1.6° C (A2) and 1.2° C (B2) in 2050s, mostly in northern, north eastern and north western regions of the country.

Maximum Potential Soil Moisture Deficit

PSMDmax increased by 11% (A2) and 4% (B2) in 2050s across the country (De Silva, 2006). Highest PSMDmax areas are located in the northern and north-eastern regions where agricultural activities are intensive and availability of water resources are under severe pressure (Figure 6). Among the dry zone areas the highest increase in PSMDmax is predicted in Batticaloa by 25% (A2) and 13 %(B2).

Annual Runoff

The annual runoff across the country is predicted to decrease by 10% (A2) and 8 % (B2) even though the annual average rainfall is predicted to increase (De Silva, 2007). However among the wet zone areas the annual runoff in Colombo and Kandy/Katugastota is predicted to increase drastically (Figure 7). In Colombo the annual runoff is predicted to increase by 40% in A2 scenario for 2050s. In Kandy/ Katugastota the predicted annual runoff for A2 scenario in 2050s is almost 100% increase compared to the baseline (1961-1990).

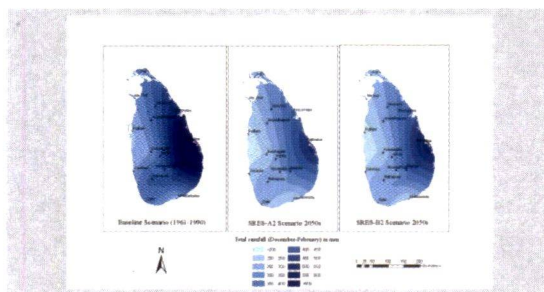

Figure 2. Spatial variation in southwest monsoon rainfall for the baseline (1961-1990) and SRES A2 and B2 scenarios for 2050s. Source: De Silva et al (2007)

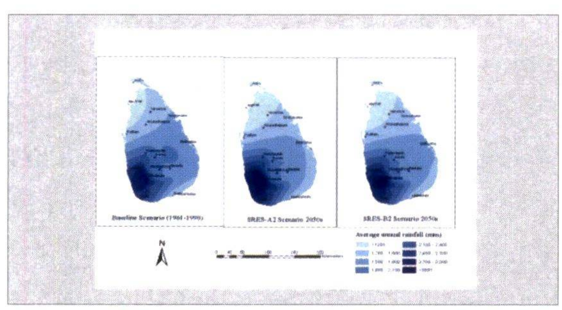

Figure 3. Spatial variation in northeast monsoon rainfall for the baseline (1961-1990) and SRES A2 and B2 scenarios for 2050s. Source: De Silva et al (2007)

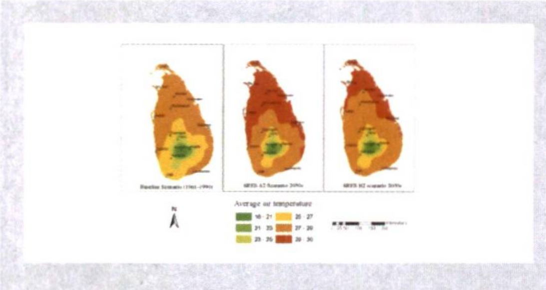

Figure 4. Spatial variation in average air temperature for the baseline (1961-1990) and SRES A2 and B2 scenarios for 2050s. Source: De Silva et al (2007)

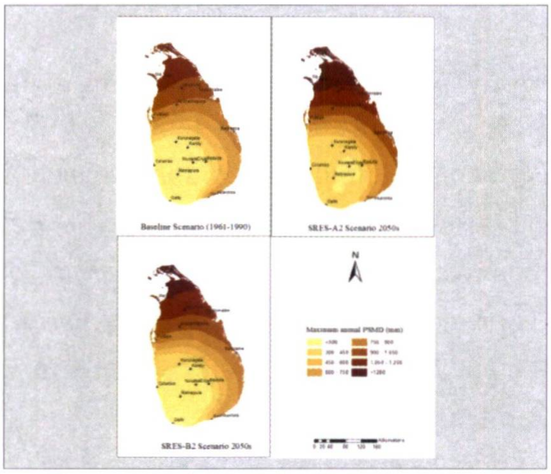

Figure 5. Spatial variation in maximum annual potential soil moisture deficit (PSMDmax) in mm, for baseline (1961-1990) and SRES A2 and B2 scenarios for 2050s. Source: De Silva et al (2007)

CONCLUSIONS AND RECOMMENDATIONS

According to the results the annual average rainfall is predicted to increase due to increase in south west monsoon in wet zone areas. Rainfall in wet zone areas such as Colombo, Kandy, Galle, Ratnapura and Nuwara Eliya are predicted to increase where the demand for water is low. During the southwest monsoon period the rainfall in Colombo is predicted to increase by 48% compared to the baseline (1961-1990) in 2050s. Therefore the predicted incremental increase is 25%, 29%, 34%, 43% in 2010, 2020, 2030 and 2040 respectively. Similarly the predicted runoff is about 40% in Colombo and almost 100% in Kandy in 2050s. Whereas the annual average rainfall is predicted to decrease due to decrease in northeast monsoon in the dry zone areas covering Vavuniya, Anuradhapura, Trincomalee and Batticaloa where agricultural activities are already water stressed and demand for water is very high. Therefore the annual average runoff too is predicted to decrease. It will create serious problems in rainfall runoff storage in existing tanks in the dry zone area and the cultivation depends on tank water storage for irrigation.

Possible Adaptation Measures

Adaptation measures should be designed store the water in wet zone areas where demand for water is low and then transfer the water to the dry zone areas where demand for water is high to ensure water security. Government should plan to store the excess water in the wet zone and divert to dry zone where water scarcity will be a severe problem. Better water resources management will be the solution to cope with impacts of climate change.

There are following adaptation measures which could minimize the impact of climate change:

For wet zone areas:

- Improving the drainage facilities by enlarging the water ways to safely divert the predicted increase in rainfall and runoff in greater Colombo and wet zone areas.

- Ban the land filling the low-lying areas which affects natural drainage of water
- Zone areas safe for settlement in sloping lands and ban all construction work in land slide prone areas.
- Encourage Rainwater harvesting in urban areas so the excess rainwater from could be stored within the land so that it could be used for washing purposes.
- Remove all the barriers for natural movement of water.

For dry zone areas:

- Paddy cultivation has to be done with limited water. Short term varieties will be beneficial. Additional irrigation water is required.
- Use water saving methods such as drip and sprinkler for other field crops.
- Cultivate low water requiring crops such as Maize and other cash crops would be beneficial.
- Store any excess water for future use.

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