EFFECTS OF POPULATION CONTROL POLICIES AS ADPATATION STRATEGY TO CLIMATE CHANGE

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1. INTRODUCTION

In evaluating the future vulnerability of water resources, population increase is expected to be far more detrimental than climate change (Vorosmarty, et al., 2000). However the global population projections employed to date in climate change research have failed to account for the inherent local variations in the natural demographic futures (Curtis et al., 2011). This research assumes regionally applied population growth control policies, resulting in favorable futures which leave more space for adaptation to climate change. Population control may be one of the simplest ways to reduce pressure on shared resources (Das Gupta et al., 2011).

2. METHOD OF ANALYSIS

Seven population scenarios (**Fig.1**) projecting to the year 2025 were formed to analyze the effect of population change on the current water resources at a horizontal resolution of 0.5°. The base year was selected as 2000. However, water resources were kept constant at the present levels, to emphasize the effects of the population scenarios. **Table 1** summarizes the seven population scenarios. The population growth rates and country population totals were obtained from the World Bank. The Centre for International Earth Science Information Network (CIESIN) provided the base year population counts per 0.5 degree grid. Current water resources per 0.5° grid were assumed as the simulated discharge out of the each grid from the Total Runoff Integrating Pathways (TRIP 1) routing scheme, for runoff routed for the four GCMs; CCSM3, MIROC3.2, CGCM 2.3.2 and UKMO. The averages for these four GCMs were taken for the IPCC SRES A1B scenario for the year 2000, to minimize the inherent regional biases in the GCMs. The per capita water availability (m^3/yr per person) under the assumed population scenarios was examined.

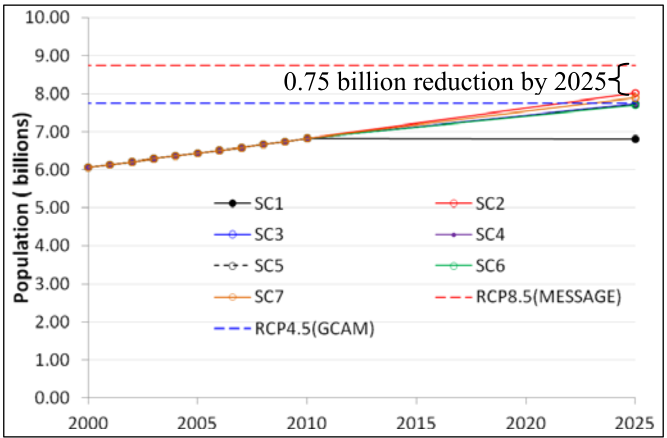

Fig. 1 Population scenarios and the resulted global populations compared with that of van Vuuren et al., 2011 for the new Representative Concentration Pathways (RCPs; two extremes only).

Of the formed population scenarios, SC1 (scenario 1), SC2 and SC3 assumes business as usual scenarios, which do not address any population control policy, with SC1 assuming constant 2010 populations. Population projections were done using the past population growth rate estimates from the World Bank until 2010. Year 2010 onwards only the population projections were applied. Therefore, every population scenario follows the actual population growth in the world until 2010 (**Fig.1**). However, intra-country population growth rates were assumed to be the average for that country even though in reality population growth rates are significantly higher in urban centers over the rural areas. SC4, SC5, SC6 assumes regional (World bank country classification based on 2010 GNI per capita) population control policies effective from the year 2017. It was assumed that motivation for population control is already perceived

Table 1 Population scenarios utilized in the study

Scenario	Policy type	Properties assumed
SC1	No policy	Constant population at 2010 levels
SC2	No policy	Constant annual growth rate (**r**) at 2010 levels
SC3	No policy	Reduction in annual growth rate (**Δr**) kept constant at the average for 2006-2010 period
SC4	Population reduction policy	Policy applied only to countries with high annual growth rates, The reduction in annual growth rate resulted by policy is **low**, The effectiveness of policy reduces with decreasing income of country, **regionally** constant Δr
SC5	Population reduction policy	Policy applied only to countries with high annual growth rates plus **ecological deficit**, The reduction in annual growth rate resulted by policy is **low** The effectiveness of policy reduces with decreasing income of country, **regionally** constant Δr
SC6	Population reduction policy	Policy applied only to countries with high annual growth rates, The reduction in annual growth rate resulted by policy is **high** The effectiveness of policy reduces with decreasing income of country, **regionally** constant Δr
SC7	Population reduction and aging control policy	Policy applied only to countries with high annual growth rates, The reduction in annual growth rate resulted by policy is **high**, The effectiveness of policy reduces with decreasing income of country, **regionally** constant Δr Population **aging control policy** applied

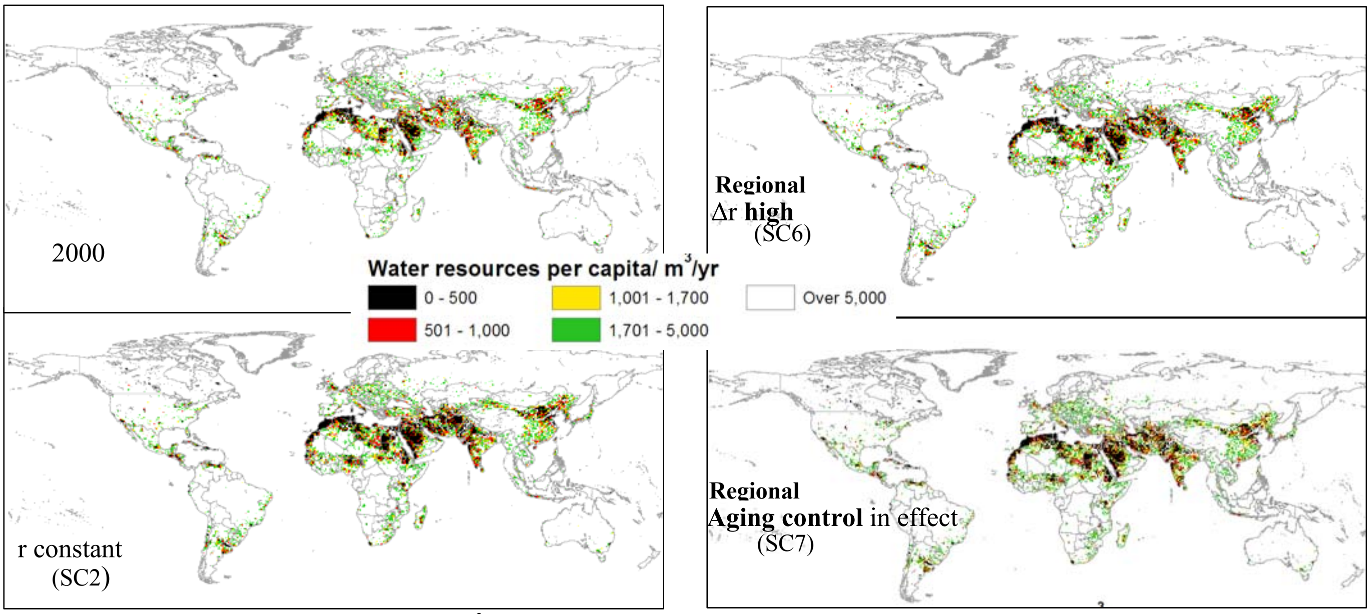

Fig. 2 The per capita water resources in 2025 (m^3/yr per person) is compared with that of 2000 for the unique population policy scenarios.

within the nations and that they start the debates on actuation and enactment of such policy now in 2012, to be effective after five years, in 2017. SC7 has a special focus on controlling the aging population, which is a common issue for most industrialized countries. The exponential population growth model (World Bank, 2011) was occupied for all population projections.

3. RESULTS AND DISCUSSION

The population control policies compared with the population scenarios used in van Vuuren et al. (2011) produce a total reduction of the global population of more than 0.75 billion by 2025 (**Fig. 1**). Therefore, population policies could be expected an effective method of reducing vulnerability due to climate change and to increase adaptive capacity of the vulnerable populations (**Fig. 2**). If projected to 2100, the effect of the policies will be substantial in fighting climate change risks. The effect of policies controlling the aging of population, although hasn't received much attention in research, is shown to overpass the reduction resulted in by the population reduction policies. Therefore, it is clear that if such population aging controls are to be accompanied along with the population reduction policies, more stringent reduction controls are necessary. In this study, the Δr assumed in SC4 and SC5 is lower than that of China, which has past experience in population controls. The above two scenarios are based on the critics on China's population policies that they are too stringent if considered the pressure on a single family unit. Nevertheless, as China is a vast country, monitoring the effectiveness of population controls are very difficult. Therefore SC6 and SC7 are based on this fact, that the effective population reductions realized will be similar to that of China for any country. However the combination of the concept of ecological deficit (See, van den Bergh et al., 1999) did not result in a noticeable difference in SC5 from SC4, by 2025.

Compared to the per capita water resources in 2000, SC2 gives the highest vulnerability for the available water resources. Even though it is not very clear, SC2 contains more red color grids, indicating highly water stressed status in those grids. SC7 introduces more green grids to SC6 for the European countries. However, SC6 and SC7 do not exhibit outstanding differences in the per capita water resources per 0.5degree grid by 2025. Nevertheless, they both give reduced vulnerability on water resources and should be investigated as possible climate change adaptation strategies to tackle climate change.

4. CONCLUSIONS

Seven population control policies were assessed for their strengths for controlling the population as strategies to reduce climate change risks on the available water resources. Compared to population projections utilized in other newly developed climate change scenarios, the developed scenarios here produce more than 0.75 billion reduction in the total global population by 2025. Therefore, their effectiveness in reducing climate change risks by 2100 could be expected to be highly significant. However, when the population reduction policies are combined with policies to limit population aging, this research implies that more stringent population reduction controls are necessary.

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