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SUMMARY OF IMPACTS OF CLIMATE CHANGE AND ADAPTATION IN WATER, AGRICULTURE, AND FORESTRY SECTORS IN INDONESIA

By

Agus P. Sari

Pelangi

Indonesia

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By Agus P. Sari

Pelangi
Jalan Danau Tondano A4, Pejompongan
Jakarta 10210, Indonesia
Tel. (62-21)-573-5020, 571-9360, 571-9361
Fax. (62-21)-573-2503
Email. apsari@pelangi.or.id

Introduction

Even if and when the Kyoto Protocol is without loopholes and is complied with by all committed countries, climate change will happen. Far from an immediate and drastic 60 – 80 percent cut as recommended by the Intergovernmental Panel on Climate Change (IPCC) to stabilize the climate system, the Protocol only required the industrialized countries — countries who are listed under Annex I of the Climate Convention, and whose quantified emissions limitations and reduction commitments are listed under Annex B of the Protocol — to reduce their collective greenhouse gas emissions on average by 5 percent below their 1990 levels in the years 2008 - 2012. This target is differentiated among the Annex I countries, ranging from a reduction of 8 percent collectively by the European Union member countries to 7 percent by the United States, to 6 percent by Japan, to an increase of 1, 8, 1nd 10 percent by Norway, Australia, and Iceland, respectively. While the Kyoto Protocol targets are obviously inadequate to prevent climate change, it is nevertheless an essential first step towards the right direction.

As a result of the increased concentration of the climate change-inducing greenhouse gases, the average temperature of Earth will increase. Along with the increase in temperature, there are adverse impacts of climate change that are devastating. The most devastating impacts to Indonesia will be the increasingly threatened water supply and food security. This paper summarizes the impacts of climate change on water, agriculture, and forestry sectors in Indonesia. The paper is based on the Indonesian Vulnerability and Adaptation Assessment, a National Communication on Climate Change, prepared by Pelangi for the Indonesian State Ministry for the Environment.

Climate scenario for Indonesia

The climate scenarios on which climate impacts are predicted are comparison among four Global Circulation Models (GCMs), namely the Canada Climate Change Model (CCCM), the United Kingdom Meteorological Office (UKMO), Goddard Institute for Space Studies (GISS), and Geophysical Fluid Dynamics Laboratory (GFDL). Data on rainfalls were collected from rain stations in 33 watershed units throughout Indonesia between 1931 and 1971. Temperature data were estimated based on Brak (1929). Grids of 0.1 x 0.1 for Java and 0.5 x 0.5 for other islands were established. Based on the grid analysis, changes in temperature and rainfall due to climate change were predicted using the four GCMs, based on the doubling of CO₂ concentration scenario.

It is instructive to note that predictions made by the four GCMs varies. All models predict increased temperature over the country ,ranging from about 1.6 – 3.0 by CCCM and UKMO to 2.0 – 4.2 by GFDL ad GISS. However, CCCM predicts less rainfall, whereas UKMO predicts more.

Water

The availability of water resources have already been of concern in Java, where 65 percent of the 210 million population in Indonesia live in the island constituting 7 percent of the country's land mass. The highest water demand in Jawa occurs in Bengawan Solo, followed by Citarum and Brantas watersheds. Water supplies in areas outside Java, namely in Sumatera, Kalimantan, and Papua, are higher due to higher rainfall and much less population.

It was assumed that the available water being 80 percent of runoff. Of which, 90 percent is for agricultural use and 10 percent for other uses. Projection of water demands were made with assumed economic growth of 6 to 6.5 percent per year, 10 percent growth of industry, and 3.5 percent of agriculture, which yielded an estimate of 4.15 percent per year increase in water demand in Indonesia.

Climate change will accelerate depletion of water resources due to changes in the patterns of rainfall and evaporation. Java, with already stressed water availability even without climate change, is expected to suffer the most from climate change. Table 1, below, shows the changes in the demand-supply ratio of 10 watersheds in Java.

Table 1.
Changes in water availability in Java due to climate change

| Watershed | Water Demand-Supply Ratio | |
|-------------------|---------------------------|---------------------|
| | 1 x CO ₂ | 2 x CO ₂ |
| Brantas | 1.12 | 0.92 |
| Citarum | 0.97 | 0.99 |
| Bengawan Solo | 0.89 | 0.94 |
| Jratun-Seluna | 0.80 | 0.83 |
| Progo-Opak | 0.68 | 0.68 |
| Pakelan Sampeyan | 0.66 | 0.70 |
| Cisadane-Ciliwung | 0.47 | 0.53 |
| Serayu | 0.39 | 0.38 |
| Citanduy | 0.33 | 0.32 |
| Ciliman-Ciujung | 0.30 | 0.32 |

Without climate change, availability of water is already stretched in Brantas watershed, with demand already surpass supply by 12 percent. Climate change will mainly increase the demand-supply ratio of water, although in some watersheds — in Serayu, Citanduy, and Brantas, they may decrease. Citarum will be hit the hardest, with Bengawan Solo to follow.

Adaptation measures should be emphasized in Java. Firstly, efficient use of water should be emphasized, while water pollution should be minimized to increase the availability of usable water. Secondly, watersheds should be better managed, including better and more integrated watershed planning, as well as better and well-enforced regulations. Thirdly, the upcoming floods and droughts should be mitigated. Lastly, the use of groundwater should be better managed.

Agriculture

Agriculture an important sector in Indonesia. Not only is agriculture provides the largest employer, it is also the base for food security. The agriculture development has been lagging behind other sectors due to lack of labor and land, which are two major inputs for the sector. Over the past decade, agriculture sector has grown only at 4.6 percent per year, lower than the 7

percent average growth rate of the whole economy. Loss of arable land continues to worsen, whereas yield losses due to pests, droughts, and floods continue to happen. It is estimated that about 20 thousand hectares of irrigated paddy fields in Java are converted into residential and industrial uses every year.

Having been pressured from these threats, agriculture sector will also be further threatened by climate change. Two main rice-production areas in Java were studied, namely Pusakanegara in the northern coast of West Java and Mojosari, which is on the flood plain of the Brantas river. In Pusakanegara, the mean annual rainfall between 1971 and 1992 was 2031 mm, whereas minimum and maximum temperatures were 23 °C and 30.7 °C, respectively. In Mojosari, the mean annual rainfall in the same period was 1785 mm, whereas minimum and maximum temperatures were 22 °C and 32.9°C, respectively. Average solar radiation in Java during this period was 20.4 megajoules per square meters (MJm⁻²).

Table 2.
Changes in agricultural yields due to climate change

| | Pusakanegara | Mojosari |
|--------------------------------------|--------------------------------|-------------------------------|
| Annual rainfall (mm) | 423 – 1681 (21 – 83 percent) | 265 – 1130 (15 – 63 percent) |
| Increase of min. temperature (°C) | 2.3 – 3.9 (10 – 17 percent) | 2.3 – 3.9 (10 – 17 percent) |
| Increase of max. temperature (°C) | 2.0 – 3.9 (9.5 – 12.5 percent) | 2.3 – 3.9 (7 – 12 percent) |
| Solar radiation (MJm ⁻²) | 0.3 – 0.7 (2.2 – 3.5 percent) | 0.2 – 0.6 (1.3 – 3.3 percent) |
| Rice yield (| 5,578 (normal year) | 6,925 (normal year) |
| | 2,637 (El Niño year) | 2,939 (El Niño year) |
| | decrease about 0.5 percent | decrease of more than 1 |
| | per year. | percent per year, |

These figures were then used in the Crop-Environment Resource Synthesis (CERES) Model to predict the impacts on 6 grain crops. The result is that in the next decade, about 0.5 percent decrease in yeald in Pusakanegara and more than 1 percent decrease in yield in Pusakanegara per year.

In the agriculture sector, the use of more resilient variety of rice — such as the gogo rancah — may be able to adapt to climate change with changes in planting time. More efficient use of water with flood control, as well as improved agricultural techniques may be advisable.

Forestry

With about 142 million ha of forest areas covering 75 percent of the landmass, Indonesia houses the third largest forest cover in the world, after Brazil and Congo. Increasing temperature may affect growth and development of vegetation, and its adaptation to other environmental factors. Assuming other environmental variables being constant, there may be a shift of vegetation from lower to higher altitude to maintain the same temperature. The following table shows some of the changes of forest types in certain areas in Indonesia due to the doubling of carbon dioxide.

Table 2.
Changes in the distribution of forest vegetation types
in five largest islands due to climate change

| Islands | Present Condition | | GCM | 2 x CO ₂ | |
|------------|-------------------|---------------------------|------|---------------------|---------------------------|
| | Code | Types | | Code | Types |
| Sumatera | 30 | Subtropical wet forest | CCCM | 23 | Warm temperate wet forest |
| | 31 | Subtropical rain forest | | 28 | Subtropical dry forest |
| | 36 | Tropical dry forest | | | |
| | 37 | Tropical moist forest | | | |
| Kalimantan | 30 | Subtropical wet forest | CCCM | 29 | Subtropical moist forest |
| | 31 | Subtropical rain forest | | | |
| | 36 | Tropical dry forest | | | |
| | 37 | Tropical moist forest | | | |
| Sulawesi | 23 | Warm temperate wet forest | GISS | 38 | Tropical wet forest |
| | 29 | Subtropical moist forest | | | |
| | 30 | Subtropical wet forest | | | |
| | 31 | Subtropical rain forest | | | |
| | 36 | Tropical dry forest | | | |
| | 37 | Tropical moist forest | | | |
| Papua | 23 | Warm temperate wet forest | | | |
| | 29 | Subtropical moist forest | | | |
| | 30 | Subtropical wet forest | | | |
| | 31 | Subtropical rain forest | | | |
| | 36 | Tropical dry forest | | | |
| | 37 | Tropical moist forest | | | |
| Java | 37 | Tropical moist forest | CCCM | 31 | Subtropical rain forest |
| | 38 | Tropical wet forest | GFDL | 36 | Tropical dry forest |
| | | | UKMO | 31 | Subtropical rain forest |

There are only few adaptation measures that can be undertaken in the case that forests are affected by climate change. Livelihood changes are necessary for those who are currently dependent on forest resources.

Concluding Note

Climate change will bring serious impacts on the availability of water, on the security of agriculture products, and on the existence of certain types of forests. Life and livelihoods of millions of Indonesians will be affected accordingly. While Kyoto Protocol is the first essential step in the right direction, the Protocol by itself will not be able to halt climate change. In this situation, adaptation is more instrumental.