Analyzing Impacts of Climate Variability and Change on Water-Food-Energy Systems: Developing A Conceptual Framework

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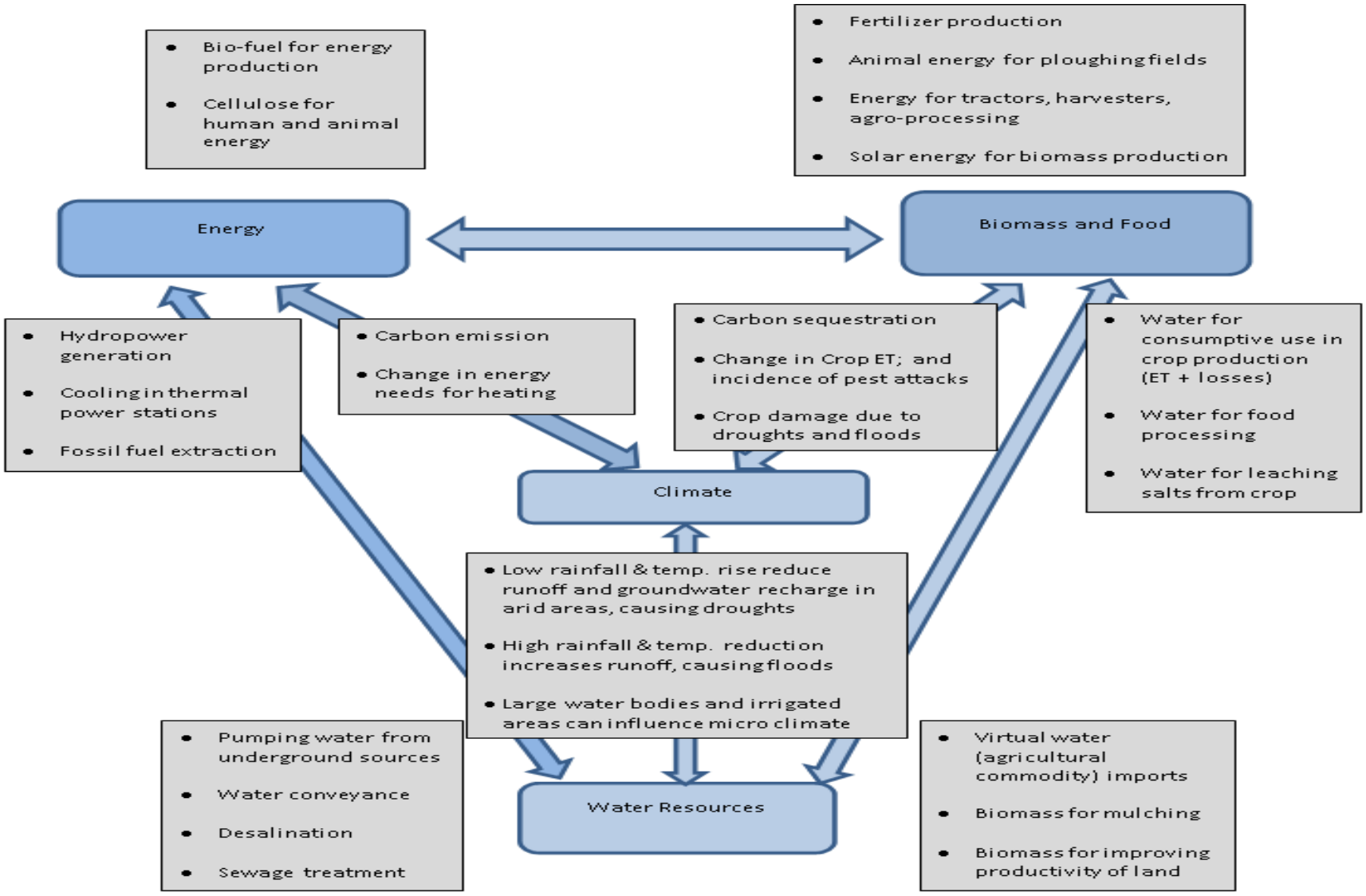
Conceptual framework for analyzing the impact of climate variability on water, energy and food systems in distinct typologies of South Asia



Conceptual Framework

- ✓ **Climate variability** can affect water resources, both adversely and favourably
- ✓ Meteorological droughts can cause hydrological stresses and water availability
- ✓ Failure of rains resulting in soil moisture stress would mean greater demand for irrigation water. Reduced humidity and increased temperature would aggravate the situation
- ✓ Reduced stream flows during droughts would lead to greater dependence on groundwater resources for irrigation
- ✓ Droughts also result in reduced recharge to groundwater and lowering of water table
- ✓ Overall reduction in renewable water availability as a result of drought can result in reduced agricultural and production

Conceptual framework

- ✓ Both crop water demand and irrigation water demand for unit of crop production increases during droughts
- ✓ But, this may not increase use of irrigation water in aggregate terms, due to water shortage; impact will be in the form of decline in crop output
- ✓ In semi arid and arid regions where annual groundwater replenishment is the major source of water for irrigation, energy demand per unit of crop production would increase
- ✓ However, the overall energy foot print in crop production may not increase as there would be overall reduction in use of water

Conceptual Framework

- ✓ However, in semi arid areas with large amount of static groundwater resources--where water availability for crop production is not severely affected in the short and medium term--, there would be overall increase in energy demand in agriculture during droughts due to:
  - ✓ Overall increase in dependence on groundwater for irrigation
  - ✓ Increase in irrigation water demand for crop production
- ✓ The resultant increase in energy consumption in agriculture in such areas would lead to greater amount of carbon emissions.

Conceptual Framework

- ✓ Climatic variation, particularly solar radiation, has a significant influence on crop yields, and certain crops have very high yields in certain regions because of climate advantage
- ✓ Climate also influence crop water productivity through solar radiation, and humidity and wind speed
- ✓ In high rainfall, humid regions, access/lack of access to groundwater would determine the degree of impact of droughts on crop outputs
- ✓ Agricultural outputs can increase in flood prone regions during droughts (if groundwater is in plenty), and vice versa

Conceptual Framework

- ✓ Frequency of occurrence of droughts is much less in humid areas. But, the drought impact could be severe in the absence of alternative source of water--high rainfall, hilly regions with no groundwater
- ✓ In high rainfall, mountainous regions (Indus, NE Himalayas, Western Ghats, Eastern Ghats), droughts can adversely affect hydropower generation
- ✓ Dependence on bio-fuel as an alternate source of energy can affect availability of fresh water resources and precious arable land for food production and excessive diversion of crop land for bio-fuel production can affect food security

Conceptual Framework

- ✓ On the other hand, temperature rise in semi arid and arid areas can affect crop yields adversely, while increasing the ET demand for water owing to temperature increase and consequent reduction in humidity
- ✓ This can reduce biomass output per unit volume of water depleted in crop production (**kg/ET**) as well
- ✓ It can also reduce the freshwater availability by causing fast depletion of water in the soil profile
- ✓ In humid regions, the effect of rise in temperature on humidity would be just opposite, and therefore may reduce ET

Conceptual Framework

- ✓ Use of water for energy production, through hydropower and bio-fuels, reduce the carbon foot prints and therefore climate impacts of energy production
- ✓ But, such strategies should be resorted to in regions which have abundant water and land resources and where energy use efficiency for biomass production is high
- ✓ It should not be resorted to regions which have extremely limited fresh water and where energy use for biomass production is high.
- ✓ It also will not be suitable in regions which have abundant amount of water, but face scarcity of land resources