LIST OF POSSIBLE APPLICATIONS OF DECADAL PREDICTION

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The **decadal** time period falls between and overlaps with **interannual variability** and **long-term climate change**. ENSO, an acronym for **E**l **N**iño-**S**outhern **O**scillation, can be considered a type of interannual variability, and climate warming is a factor in long-term climate change. Many of the applications of decadal prediction rely on this overlap.

Overlap with interannual variability
Changes in the nature and impact of ENSO are part of decadal variability. ENSO teleconnection patterns seem to be sensitive to decadal variability, which could introduce uncertainties in regional impacts of an ENSO event. Many of the applications below discuss how understanding of decadal changes in ENSO will help humanity. For example, when, if ever, will we see ENSO events as strong as those of 1982/83 and 1997/98? Will La Niña events of the next decade be strong or weak?

Overlap with long term climate change
Decadal variability merges into long-term climate change at longer periods. Scientists now realize the near certainty of long-term climate warming, but are not as certain how this warming will differ from present decadal climate variability. Scientists are often asked questions such as "Is this warm summer part of climate warming?", or "Can we expect stronger monsoons and typhoons in this warming climate?" Imagine how it would be if scientists had the answer! If warmer or wetter weather in a region is part of a climate-change trend, societies and individuals will be able to plan for the future. At present, there are several global and regional initiatives to establish long term policies for Climate Change adaptation; however, in most of the cases, the future climate scenarios have been assumed only under a global climate change trend, without consideration of the risk that the variability could be modulated with signal of a decadal temporal scale.

APPLICATIONS

Climate-related diseases

Decadal variability is closely related to health, mainly applied to the possible changes in temperature and rainfall, and the estimation of propagation of disease vectors. Diseases carried by insects expand in geographical range as temperatures rise and fall. Warmer weather enables tropical insects to carry diseases toward higher latitudes. Wetter weather allows malaria to spread to new regions, and increase in severity in already-infected areas. Decadal predictions will enable societies and agencies to enhance disease treatments and mitigation, and will even determine how populations move.

Agricultural planning.

The influence of decadal variability in the change of the spatial and temporal rainfalls patterns in many regions of the world, is a big issue for long term agricultural planning, mainly related with contingency measures and policies to mitigate and to get an effective adaptation of communities to these new scenarios, reducing economic losses and protecting small and big public and private investments in this sector. We list a few examples below.

- The differing impacts of large and minor ENSO events are well known. If improved decadal predictions can forecast the returns of major events like the 1997/98 ENSO, entire continents will be able to plan for floods, forest fires, food storage and crop changes.
- Agriculture in temperate areas such as east Asia is characterized by right crop for right land. It is vulnerable to the influence of decadal changes in temperature and/or rainfall. Decadal predictions will be beneficial to nation-wide planning for farmland utilization and choice of crops/varieties.
- Most south Asian farming relies on monsoon rainfall, and will suffer or expand if this rainfall changes in amount or timing. Decadal predictions will allow governments and farmers to plan for changes in monsoon-region farming. For example, water reservoirs can be built in less than a decade, and can redirect rainfall to regions newly hit by reduced monsoons.
- In regions where irrigation is already the main water supply, more accurate decadal predictions will lead to better planning of water uses.

Drinking water

Many communities lack adequate drinking water. The impact of climate change on supplies of drinking water will be mitigated with better predictions of decadal climate variability. Such predictions will provide answers to questions such as, “Is our city’s fresh water reservoir able to supply water through the droughts of the next 30 years?”, “Will our underground reservoirs collect more or less water in the next 30 years?”, “If our cities expand in population and consume more water, will there be sufficient water for farmers?”

Sea Level Rise
Sea level rise accompanies climate warming. Coastal communities, especially islands in the Pacific Ocean, need improved decadal predictions of sea level rise for planning their shorelines, and even for moving entire communities.

Tourism
Many coastal and arid regions are promoting tourism, yet these same regions are sensitive to sea level rise and diminished drinking water supplies as the global climate warms. Other tourist centers are located along typhoon and hurricane tracks. Planning for tourism will benefit from better decadal predictions of these climate-related changes.

Forest planning
Decadal predictions can permit foresters to determine the type of trees to plant in cultivated forests. Many of the commercially harvested forests now are replanted manually with trees selected for the local climate. Knowledge of decadal variability will permit planters to select appropriate types of trees that will best survive their vulnerable first few years.

- An example from Canada is devastation by the mountain pine beetle. It is normally killed by cold winters, but absence of warm winters in the past decade has allowed this beetle to spread over most pine forests in western Canada. Will cold winters return? Improved decadal predictions would answer this question and help local foresters determine what trees to replant, and how to manage this disaster.

Fisheries
Many fish stocks experience large multi-decadal variability, which is presumably related to Pacific decadal variability. Fishing societies require several years of lead time to build and maintain their fleets, to set up or shut down shore processing plants, and to change marketing. Expected fisheries variability due to temperature changes of a few degrees Celsius can be anticipated in many ocean regions. Decadal predictions of temperatures will assist fishing industries in planning catches and marketing, and in building or moving processing plants. It will assist fisheries managers in assigning quotas.

- For example, true sardine stock near Japan has been rapidly decreasing since the mid 1980s, delivering a fatal blow to fishing and related industries such as fish-processing and distribution, in regions depending on sardine fishing. Decadal prediction can allow governments and industries to prepare for such steady changes in fish catch.
- The anchovy, sardine and herring stocks along the eastern Pacific continental margin have all experienced decadal changes, likely related to climate variability. Improved predictions of ocean factors responsible for this variability will enable long-term planning.

Hurricane predictions.
The link between ocean temperatures in the tropics and strength of hurricanes is

appreciated in the North Atlantic, and also in other hurricane and typhoon regions. The role of temperature of the upper troposphere and lower stratosphere is also appreciated. Reliable decadal predictions in this atmospheric layer and in the surface ocean will enable predictions of the strength of hurricanes, enabling the deployment of resources to prevent damage. Decadal predictions will determine insurance rates, the amount of construction near the ocean, and even the long-term movement of populations toward or away from the coast.

Arctic navigation
Higher temperatures might open up navigation through the Arctic in summer. Research suggests the northeast passage (north of Russia) might open up before the northwest Passage (through the Canadian Archipelago). Both routes will enable fast transit between North Pacific and North Atlantic Oceans. Decadal predictions of continued Arctic warming will allow planning of routes and ship construction, and building and deployments of ice breakers.

Permafrost and methane gas emissions.
Many high latitude regions of the Northern Hemisphere are covered by permafrost. With continuing warming, permafrost of these regions will continue to melt and methane gas emissions will increase. Accurate predictions of continuing warming in these regions will allow enhanced efforts to determine rates of methane gas release and possible mitigation. Improved decadal predictions will enable planning for repairs and redesign of communities, roads and railways presently build on permafrost.

Electrical power generation
This industry requires accurate predictions of precipitation and temperatures to determine the levels to maintain in reservoirs. Decadal predictions will speed or slow plans for construction of new electrical stations, and will be a factor in negotiating sales of power between states. Decadal predictions of storm tracks are essential in regions where wind energy can be harnessed to generate electricity, especially over the ocean where construction costs and electrical output depend greatly on wind intensity. The use of air conditioning is expanding, especially in the tropics. Electrical utilities try to maintain peak capacity to supply power on the hottest days when usage is greatest. Decadal predictions of hottest summers will enable these utilities to build capacity to meet these demands, or plan for mitigation on the hottest days.

Shipping and offshore construction
These industries are vulnerable to intense storms with strong winds. With accurate decadal predictions of storm tracks and intensity, these industries will be able to change their construction methods to adapt. Better interannual variability will not help, because all these projects require many years to pan and build, and all their projects last for decades.

SUMMARY

Improved planning is the main impact of improved decadal predictions. This planning implies development strategies, resource allocation, and set up of national priorities. Poverty reduction around the world could be enhanced with understanding and dissemination of decadal climate variability effects. As consequence, adaptation or mitigation policies and actions could ensure sustainable development in most vulnerable countries around the world. All humanity wants to plan for the future, usually considered in terms of decades. If the future depends on the weather, then these predictions will allow better planning.