

## Observations to support adaptation: Principles, scales and decision-making

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As has been long noted, a comprehensive, coordinated observing system is the backbone of any Earth information system. Demands are increasingly placed on earth observation and prediction systems and attendant services to address the needs of vulnerable sectors including energy, water, health, transportation, agriculture, disaster risk reduction, and national security. Climate services include building capacity to interpret information and guide data standards in the promotion of social and economic development across climate timescales climate. Key concerns arise from forcings on subseasonal to decadal and longer-term timescales, and land surface feedbacks on forecast reliability, among others. Climate data and information are central for developing decision options that are sensitive to climate-related uncertainties and the design of flexible adaptation pathways. Ideally monitoring should be action oriented to support climate risk assessment and adaptation including informing robust decision making to multiple risks over the long term. Based on the experience of global observations programs and empirical research we outline (1) Challenges in developing effective monitoring and climate information systems to support adaptation, (2) The types of observations of critical importance needed for sector planning to enhance food, water and energy security, and to improve early warning for disaster risk reduction, (3) Observations needed for adaptation including the identification of thresholds, (4) The benefits and the limits of linking regional model output to local observations including analogs and verification for adaptation planning.

To support these goals a robust systems of integrated observations are needed to characterize the uncertainty surrounding emergent risks including overcoming unrealistically precise information demands. While monitoring systems design and operation should be guided by the standards and requirements of management, support is needed for those who provide information to the system (e.g. hydromet services). Drawing on information needs to support climate risk management (in drought, water resources and other areas) we outline principles of effective monitoring and develop preliminary strategic guidance for information systems to support preparedness and adaptation being developed through the GEO, GCOS and Global and national frameworks for climate services. Issues and opportunities will be highlighted through specific cases such as sea level and drought.