Principles of Resilience

Principle	Meaning	Author(s)
Maintain diversity and redundancy	Diversity refers to variety of elements, balance (how many of each element) and disparity (how different the elements are from one another) Diversity in social-ecological systems (SES) encompasses biodiversity, spatial heterogeneity, livelihood strategies and institutional diversity. Redundancy is the opposite of disparity. Diversity and redundancy are important for resilience because they provide options for responding to change and disturbance. This can be in form of learning, innovations and adaptations to on-going changes.	Biggs et al., (2012) Stirling (2007)
Manage slow variables and feedbacks	Fostering an understanding of SES as complex adaptive systems among actors in SES management enhances the resilience of ecological systems (ES) by emphasizing holistic approaches, the management of multiple ES and trade-offs in an integrated way, and the importance of slow variables, lags, and feedbacks in SES dynamics. This can be facilitated by a number of analytical frameworks such as MEA and adaptive cycle.	Paul-Wostly (2009) Holling (1996) Biggs et al. (2012)
Foster and understanding of social-ecological systems as complex adaptive systems	Fostering an understanding of SES as complex adaptive systems among actors in SES management enhances the resilience of ES by emphasizing holistic approaches, the management of multiple ES and trade-offs in an integrated way, and the importance of slow variables, lags, and feedbacks in SES dynamics. This can be facilitated by a number of analytical frameworks such as MEA and adaptive cycle.	Olsson et al. (2004) Biggs et al. (2012)
Broaden Participation	Participation is defined as the active engagement of relevant stakeholders in the management and governance processes. It can occur in different stages of management processes: identifying problems and goals to implement policy, monitoring results and evaluating outcomes. Participation is central to facilitating collective action required to respond to disturbances and changes in SES.	Biggs et al. (2012) Stringer et al. (2006)

Promote polycentric governance systems	Polycentric refers to a governance system with multiple governing authorities at different scales Governance is defined as the exercise of deliberation and decision making among groups of people who have various sources of authority to act and may be practiced through a variety of organizational forms (e.g. bureaucratic department, rural councils, non-profit organisation). In polycentric systems, each governance system has independence within a specified geographic area and domain of authority, and each unit, may link with others horizontally on common issues and be nested within broader governance units vertically.	Biggs et al. (2012) Ostrom (2005)
Manage Connectivity	Connectivity is defined as the way and degree to which resources, species or social actors disperse, migrate or interact across ecological and social landscapes. In SES connectivity facilitates the exchange of material and information necessary for the functioning of social-ecological process. It affects the spread of the disturbances and its recovery. Connectivity facilitates the resilience of ES through enhanced governance opportunities. High levels of connectivity among social groups increases information sharing and develop the trust and reciprocity necessary for collective action.	Biggs et al. (2012)
Encourage learning and experimentation	Learning is the process of modifying existing or acquiring new knowledge, behaviors, skills, values or preferences at individual, group or societal level. Social learning occurs through social interactions and can take place through intentional, facilitated process or it can be an emergent outcome. The need for learning is based on the view that knowledge is always incomplete and that uncertainties and changes are possible in complex SES. Traditional practices underpin the generation, accumulation and transmission of knowledge and institutions for responding to and managing ecological changes.	Biggs et al. (2012) Olsson et al. (2004)