



## Evaluating natural flood management measures using an ecosystem based adaptation framework: a meta-analysis

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Climate change is projected to alter river flows and the magnitude/frequency characteristics of floods and droughts. As a result flood risk is expected to increase with environmental, social and economic impacts. Traditionally flood risk management has been heavily relying on engineering measures, however with climate change their capacity to provide protection is expected to decrease. Ecosystem-based adaptation highlights the interdependence of human and natural systems, and the potential to buffer the impacts of climate change by maintaining functioning ecosystems that continue to provide multiple societal benefits. Natural flood management measures have the potential to provide a greater adaptive capacity to negate the impacts of climate change and provide ancillary benefits. To understand the impacts of different NFM measures on ecosystem services a meta-analysis was undertaken. Twenty five studies from across the world were pulled together to assess their effectiveness on reducing the flood risk but also on other ecosystems services as defined by the UK National Ecosystem Assessment, which distinguishes between provisioning, regulating, cultural and supporting services. Four categories of NFM measures were considered: (i) afforestation measures, (ii) drainage and blocking the drains, (iii) wetland restoration and (iv) combined measures. Woodland expansion measures provide significant benefits for flood protection more pronounced for low magnitude events, but also for other services such as carbon sequestration and water quality. These measures however will come at a cost for livestock and crop provisioning services as a result of land use changes. Drainage operations and blocking the drains have mixed impacts on carbon sequestration and water quality depending on soil type, landscape settings and local characteristics. Wetland and floodplain restoration measures have generally a few disbenefits and provide improvements for regulating and supporting services. Mixed measures are expected to have cumulative benefits which are likely to outweigh disbenefits and packages of actions are recommended rather than individual or localised actions for an integrated catchment management approach. NFM measures have the potential to provide significant environmental gains, however the time lags between the moment these measures are set in place until they become effective must be considered especially in flood vulnerable communities where there is already a stakeholders demand to decrease the risk of flooding even for the current level of exposure.