Measuring or modelling river flow discharge

River and estuary discharge, or the volume of water moving downstream per unit of time, is an essential metric for understanding water quantity within an ecosystem and availability for human use. This section describes key considerations for monitoring discharge and provides criteria for discharge data generated to support Indicator 6.6.1.

Common in-situ monitoring methods: There are a variety of methods for monitoring discharge *in situ* and selection should be based on the size and type of the waterbody, terrain and velocity of water flow, the desired accuracy of measurement, as well as finances available. Two the most common and accessible approaches are gauging stations and using current meters. In many countries, gauging stations are the most prevalent means for measuring river discharge as they allow even for continuous and often real-time monitoring. These are fixed locations along a river or estuary where the change in water surface level (stage) is monitored at locations where a unique relationship exists between stage and flow and a so-called rating curve can be produced. Water surface height (stage) is captured frequently, and the discharge estimated, most often at monthly intervals but in many places, this is available at daily intervals or even continuously. Current meters and other instruments can be used to monitor flow and calculate discharge. For example, propeller, pygmy or electromagnetic current meters are often used to measure velocity and can be used in conjunction with cross-sectional area methods to obtain flow rates. Acoustic Doppler Current Profiler's (ADCPs) are widely used for larger rivers/estuaries to accurately measure bed depth, velocity, and discharge. They are often attached to boats and dragged along a waterbody, but permanent installations can also be found, sending out acoustic waves and measuring acoustic reflectance. Meters and instruments like ADCPs are significantly more costly than other methods of measurement and require skilled operators and good maintenance programmes. However, in larger rivers they may be the most appropriate option, especially during high flow conditions.

Location of Monitoring: The chosen monitoring method may dictate where along a river or estuary the discharge is captured. For example, if fixed weirs are in place, monitoring will always take place here. Since *in situ* discharge monitoring can be time and cost-intensive, choosing strategic locations which represent a whole river or estuary is recommended. The minimum monitoring effort is to locate one flow measuring site within proximity to each basin's exit (into another basin). In addition, monitoring at the exit point from all major tributaries adds a substantial level of information. Where there is a local impact on discharge due to human influence, then it is recommended to monitor flow upstream and downstream of these areas so that the overall situation can be managed.

Frequency of Monitoring: The quantity of water in a river or estuary can change rapidly in response to rainfall and weather patterns. The more data on discharge there is, the higher the accuracy is of that discharge data. However, again it is important to focus efforts and choose a strategic frequency for monitoring. Data on discharge should ideally be collected at a given location once a month at minimum (ideally at a daily frequency) and this data can then be used to determine annual and long-term trends. The quantity of water in estuaries may be significantly influenced by tidal inflows, thus this indicator is limited to the freshwater inflows to the estuary from the upstream river.

Modelling Discharge: In addition to *in situ* monitoring which always is impacted by all forms of flow moderation, storage or abstractions upstream, discharge may also be modelled from one of the many available models which use climatic and land-use data, amongst other data, to estimate both natural and present-day flows. Globally hydrological model applications are available and in some countries these or similar models have been developed for the local context and are calibrated using real measured data. It is recommended that modelled discharge data is complimented by measured *in situ* data wherever possible to ensure accuracy. Conceptual hydrological models for flow and discharge estimation are normally less amenable to detecting the flow impacts of minor land-cover changes over time as the models are calibrated on historical flow data and associated land-use conditions.