FOOD AND AGRICULTURE OF THE UN

SEEA for INLAND CAPTURE FISHERIES & AQUACULTURE

Working document

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SECTION 1 - SEEA CLASSIFICATION OF INLAND WATERS-

In order to account for different existing water resources, the SEEA adopt the following classification of inland waters.

1.1 SEEA CLASSIFICATION OF INLAND WATERS

In the SEEA Central framework 'inland waters comprise: surface water, groundwater and soil water within the territory of reference.' These three categories of water resources are defined as follows:

Surface water: water which flows over or is stored on the ground surface. It includes: artificial reservoirs, lakes, rivers and streams, glaciers, snow and ice.

Groundwater: water which collects in porous layers of underground formations known as aquifers.

Soil water: water suspended in the uppermost belt of soil, or in the zone of aeration near the ground surface, that can be discharged in to the atmosphere by evapo-transpiration.

Moreover, the surface waters are distinguished into four classes:

1 **Surface water**
1.1 Artificial reservoirs
1.2 Lakes
1.3 Rivers and streams
1.4 Glaciers, snow and ice

The SEEA classification of inland waters is suitable to describe water flows in different compartments (surface, groundwater and soil), but does not describe in detail the different array of aquatic ecosystems, which can be constituted by aquatic classes such as lakes, rivers or reservoirs, but also by water and soil mixed classes such as wetlands and deltas and seasonally flooded areas. Moreover, the SEEA classification of inland waters mainly represent freshwater resources, while inland water resources occur in a variation of salinity level from freshwater to brackish to saline water areas.

Thus, the SEEA classification of the land cover classes (Table 1) better describes important water resources for inland capture fisheries and aquaculture rather than the classification scheme of inland waters (see page 276). This is also congruent to the fact that water resources for inland capture fisheries and aquaculture are better represented and measured by water surface rather than water volume.

Table 1 SEEA land cover classification

Artificial surfaces (including urban and associated areas)	*The category is composed of any type of artificial surfaces.*
Herbaceous crops	*The category is composed of a main layer of cultivated herbaceous plants.*
Woody crops	*The category is composed of a main layer of cultivated tree or shrub plants.*
Multiple or layered crops	*The category is composed of at least two layers of cultivated woody and herbaceous plants or different layers of cultivated plants combined with natural vegetation.*
Grassland	*The category is composed of a main layer of natural herbaceous vegetation with a cover from 10-100%.*
Tree covered areas	*The category is composed of a main layer of natural trees with a cover from 10–100%*
Shrub covered areas	*The category is composed of a main layer of natural shrubs with a cover from 10–100%*
Sparsely natural vegetated areas	*The category is composed of any type of natural vegetation (all growth forms) with a cover from 2-10%.*
Terrestrial barren land	*The category is composed of abiotic natural surfaces.*
Permanent snow and glaciers	*The category is composed of any type of glacier and perennial snow with persistence of 12 months per year.*
Inland water bodies	*The category is composed of any type of inland water body with a water persistence of 12 months per year.*
Shrubs and/or herbaceous vegetation, aquatic or regularly flooded	*The category is composed of natural shrubs or herbs with a cover from 10-100% in aquatic or regularly flooded areas with water persistence from 2 to 12 months per year.*
Coastal water bodies and inter-tidal areas	*The category is composed on the basis of geographical features in relation to the sea (lagoons and estuaries) and abiotic surfaces subject to water persistence (inter-tidal variations).*
Mangroves	*The category is composed of natural trees with a cover from 10-100% in aquatic or regularly flooded areas in salt and brackish water.*

1.2. GUIDELINES FOR IMPLEMENTATION OF SEEA CLASSIFICATION OF INLAND WATERS

The implementation of the SEEA classification of inland waters to the pilot study of Malawi (see par.) led to the formulation of several suggestions for adjustments to this classification aimed at:

- Providing a more comprehensive description of existing water resources in the country;
- Describing water resources important for inland capture fisheries and aquaculture;
- Including all types of water resources which can be used in case of water scarcity and water conflict.

In the modified SEEA classification of inland waters, surface waters are first divided into two broad categories: natural surface water and artificial surface water. Moreover, the natural surface waters are further distinguished into includes three types of water resources: ‘Permanent inland waters’, ‘Seasonal flooded areas’ and the ‘Rice areas’.

In addition, both permanent inland waters and seasonally flooded areas are broke down into major water resources/fishing areas. Although the break down into sub-categories will not be able to cover all existing water resources/fishing areas in the country but will cover only a certain percentage of the total permanent inland waters and seasonally flooded areas, this will constitute very valuable information for water and fishery management.

Table 1 Modified SEEA classification of inland waters

Opening stock
NATURAL SURFACE WATER
a. Permanent inland water (lakes, artificial reservoir, river and streams)
water resource/fishing areas' # 1
water resource/fishing areas' # 2
water resource/fishing areas' # 3
etc.
b. Seasonal flooded areas
Seasonally flooded area # 1
Seasonally flooded area # 2
c. Rice areas
d. Glaciers, snow and ice
Sub-total (a + b) Maximum extent of inland surface water area
Sub-total (a - b) Minimum extent of inland surface water area
ARTIFICIAL SURFACE WATER
Aquaculture ponds
Earth dam for irrigation
Dam for municipal water supply
Closing stock

Note: Grey shaded rows indicate classes that are already in place in the SEEA classification system

1.2.1 Creating categories for permanent waters and seasonal flooded areas

The first guideline considers the distinction between permanent and seasonal flooded areas. Permanent inland waters are defined as the lakes, artificial reservoirs rivers and streams. All these categories are already included in the current SEEA classification.

Seasonally flooded areas instead include 'the inundated areas created by the seasonal overflowing of water from river banks and/or seasonal fluctuations of surfaces of lakes and swamps that are located in the landwards interior part of the country boundary'.

Seasonally flooded areas are key areas for inland capture fisheries as they are shallow water, protected by the river current, very rich in nutrients, which are used for reproduction sites and nursery of many tropical fish species. Thus, not only they constitute areas with the highest productivity (kg of fish harvested by hectare of water), but they support also fish recruitment in rivers and also in connected water bodies.

Seasonally flooded areas are naturally associated to major river system in the tropical areas. The overflowing of rivers or lakes is triggered by monsoon precipitations, but the establishment of flooded areas is also dependent on the control of water flow which is in place in the watershed. The alteration of the natural water flow can occur through modification of river course, flood control embankments, the diversion of water from river into irrigation canals, the withdrawal of water for productive activities (industrial and hydro-power generation) as well as for domestic use. Thus, the occurrence of seasonally flooded area can be considered the combined result of climatic/meteorological factors and of water management.

In order to account for this additional surface of water, an additional category called 'Maximum extent of inland surface area' has been proposed for the SEEA classification

Maximum extent of inland surface water area - is the largest water surface area recorded, including seasonal flooding, in a year, in general during high-water season. Whether it is fresh, brackish or salt water, it includes seasonal overflowing of water from river banks and seasonal fluctuations of surfaces of lakes, swamps or water holdings that are located in the landwards interior part of the country boundary. If no seasonal fluctuation of water level is recorded in the country, the subtotal equals to amount of permanent inland waters.

In a similar way the 'Minimum extent of inland surface water area' accounts for potential contraction of water surface. This phenomenon is usually related to shallow lakes which can be highly affected by climatic anomalies with increased evaporation rate and reduced precipitations and record oscillation of their water level. Usually the contraction of open water is a gradual process that can be observed in time often described as drying up of lakes. Contraction of water surface can occur in 'Seepage lakes', which are landlocked water bodies whose principal source of water is precipitation or runoff, supplemented by groundwater from the immediate drainage area. In most severe cases contraction of water surface can be observed also in 'Drainage lakes' which have no inlet, but have one or more continuously flowing outlet. The primary source of water of drainage lakes is precipitation and direct drainage from the surrounding land but they are not fed by groundwater. Frequently, the water levels in drained lakes will fluctuate depending on the supply of water and this will cause a major fluctuation in the water flow of the outlets, which in situation of water scarcity can become intermittent.

Minimum extent of inland surface water area - is the minimum water surface area recorded in a year, in general during low-water season. Whether it is fresh, brackish or salt water, it includes seasonal drainage of water and seasonal shrinkages of water surfaces of lakes, swamps or water holdings that are located in the landwards part of the country boundary. If no seasonal fluctuation of water level is recorded in the country, the subtotal equals to amount of permanent inland waters.

Permanent water resources represent the steady component of water resources while the 'Maximum extent of inland surface water area' and 'Minimum extent of inland surface water area' will reflect fluctuations respectively above and below the baseline of the permanent water resources.

1.2.2 Creating a category for rice areas

Rice fields with water - is a maximum extent of rice field area fulfilled with waters during the high-water season of the year. It includes both rainfed and deep rice cultivations as well as irrigated rice areas. The measurement refers to the area physically covered by water. If the area is fulfilled with water more than once a year, it is counted only once.

1.2.3 Creating a section for artificial waters

The current SEEA classification of inland water does not include a specific section on artificial surface waters. Artificial reservoirs are considered within the surface waters (and within the permanent inland waters of the modified SEEA classification). The definition of artificial reservoir of this category considers purpose built reservoirs used for storage, regulation and control of water resources.

Thus, this category include large artificial water bodies that similarly to lakes function as major storage system in the country and represent multi-purpose reservoirs.

• Inclusion of artificial water constituted by aquaculture ponds

In the SEEA Central framework the water used for aquaculture is considered within a land use classification which considers ‘Inland waters used for aquaculture or holding facilities’. However, in developing countries aquaculture is mainly carried out in outdoor aquaculture ponds. Aquaculture ponds are often artificial made with relatively shallow and usually small body of still water or with a low refreshment rate. In this report the term ‘aquaculture pond’ indicates a body of water used for aquaculture purposes with no specific reference to the stage of the biological cycle, such as growing, fattening, maturation, reproduction, hatching or the cultured species.

Aquaculture ponds should be included within the list of artificial water as similarly to natural surface water they represent a storage system in place in the country. When aquaculture ponds are only supplied by precipitations and groundwater they are similar to ‘seepage lakes’, while when they are supplied by a inlet but have no outlet (as most of aquaculture ponds) they are similar to ‘terminal lakes’.

As natural surface waters aquaculture ponds can be subject to water reduction due to increased evaporation rate or to increased pressure on existing water resources. It is important to list them as a separate category as regardless of their small extent as surface water they can have great economic value which will vary according to the production intensity (e.g. extensive, semi-intensive or intensive) and the commercial value of the cultured species.

• Inclusion of other artificial water

In the SEEA Central framework the classification of inland waters currently does not consider artificial surface water constituted by earth dams which were created for irrigation purposes. Although earth dams are often represented by spatially scattered bodies of still water, they can occur in very high number. Thus their cumulative extent should be represented within the artificial water resources given also their important role to support agriculture activities.

1.2.4 Subdivision in major water resources/fishing areas

In the SEEA Central framework the evaluation of water resources is carried out at national level. The rationale of the asset table is to aggregate all water resources by category and to measure the eventual variation recorded between the initial accounting period (opening stock) and the final accounting period (closing stock).

However, when asset table are implemented in such a way that besides the total amount recorded at national level asset tables also contain detailed information on the existing major water resources/fishing areas, this boost the helpfulness of SEEA for water management and decision making. The importance of a breakdown in major water resources/fishing areas will be further illustrated by the example reported for water asset account in Malawi.

The criteria to be used to identify such breakdown can be summarized below:

1. Analyze which is the breakdown used to record inland capture fisheries statistics
2. Associate the inland capture fisheries statistics to existing watersheds in the country

In this process of data harmonization and alignment two cases can occur. When a single watershed include more than one important water resources for which distinct inland capture fisheries statistics are collected, the information should be reported by water resources as this contain the greater level resolution of the information. When a country includes one or more great lakes, these lakes lie outside the water basin delineation. This is because watersheds boundaries include all the source area contributing surface water to a single defined outlet point which by definition is physically delineated by the area upstream from a given outlet point.

Thus, the final breakdown in major water resources/fishing areas will consider the watershed delineation as baseline information, but will also include information for important water resources/fishing areas within each watershed and information for large lake which are not part of any watershed.

• Specification of the salinity level of the major water resources

In the SEEA Central framework the classification all inland water bodies are considered as all surface water comprises all water that flows over or is stored on the ground surface regardless of its salinity levels. Freshwater is naturally occurring water having a low concentration of salt. Brackish water has salt concentrations between that of fresh and marine water.
In the SEEA no clear guidelines is provided with respect on the salinity level as it is stated that "Countries may choose to present accounts by salinity levels or for freshwater only".

There is clearly a problem in the harmonization in the definition of the categories of salinity level (freshwater, brackish and sea water) as countries often use different threshold values to distinguish between freshwater and brackish water. Moreover, often water characteristic in some inland and shallow lake can be reported as saline.

Because of the lack of standardization it will be advisable to report the actual salinity value; however in the lack of detailed information a qualitative indication of a higher salinity level of some water resources could provide important clue on the potential water use and the likelihood of some water conflict.

Water conflicts are expected to be highest for freshwater resources, which are ready available with no additional cost for all intended uses.
On the contrary brackish water, if they are no previously treated, can be used only for a subset of potential use such as for industrial purposes (e.g. cooling water), for desalination or irrigation of some crops and for aquaculture of some species.

In particular, freshwater resources, such as lakes and rivers, include freshwater species in a relative higher percentage compared with diadromous species which are represented in a relative smaller percentage. On the contrary brackish water resources, such as coastal lagoons and estuaries host diadromous species in higher percentage and freshwater species in a smaller percentage.

Thus, an overview on the salinity level of the existing water resources can provide important information for fishery management as well as for water management. The knowledge of the salinity level of the different water resources can point out the likelihood of different competing uses on the existing water resources and can contribute to provide information to increase the efficiency of water resources utilization.

APPENDIX A
– EXAMPLE OF IMPLEMENTATION OF THE SEEA LAND COVER CLASSIFICATION –
THE FISHERY PERSPECTIVE

FAO has recently completed an “Atlas of Malawi land cover and land change 1990-2010” (FAO, 2012). The main data sources include satellite imagery from LANDSAT ETM sensor (composite band 432, 2010-2011) and high resolution remote sensing images from Google Earth. The Land cover is constituted by 230,000 polygons. Each polygon is classified attributed to one of the 24 land cover classes using the Land Cover Classification System (LCCS).

The SEEA land cover classification constituted by 13 land cover classes was applied to the existing Atlas of Malawi. As shown in the Table 2 some classes were empty as there was no information on the description of the land cover classes (i.e. multiple or layered crops) or the classes were not represented in the country (i.e. Permanent snow and glaciers, mangroves, coastal water bodies and inter-tidal areas).

Table 2 Reclassification of the land cover map (2010-2011) of Malawi with the SEEA land cover

SEEA land cover classification	Surface (km2)
Artificial surface	1,709
Herbaceous crops	47,253
Woody crops	1,365
Multiple or layered crops	-
Grassland	1,087
Tree covered areas	36,769
Mangroves	-
Shrub covered areas	1,323
Shrubs and/or herbaceous vegetation, aquatic or regularly flooded	4,322
Sparsely natural vegetated areas	-
Barren land	207
Permanent snow and glaciers	-
Inland water bodies	1,313
Coastal water bodies and inter-tidal areas	-
TOTAL LAND AREA	**95,347**
lake Malawi	**22,009**
TOTAL COUNTRY AREA	**117,356**

One misalignment occurring between the SEEA land cover classification and the Land Cover Classification System is that the SEEA land cover classification distinguishes amongst the woody and herbaceous crops, but does not include shrub crops. In the Atlas of Malawi shrub crops are represented by tea plantations and other rainfed shrub crops. Thus, these two shrub classes were included into the SEEA land cover class of woody crops.

It is important to note that the SEEA land cover classification is quite an aggregated legend, which consists only of 13 classes. This level of aggregation might hide some information which is important for the fishery sector (i.e. Inland capture fishery and aquaculture).

As previously mentioned, from the fishery perspective it might be relevant to have information also on the extent of rice cultivated areas (par. 1.2.2)

However, it is also important to know what is the extent of the irrigated areas as well as the extent of small size fields, which are cultivated by using the natural river seasonal flooding (i.e. dambos). It is important to note that in Malawi not all dambos are cultivated but about 4,322 km^2 is still constituted by herbaceous vegetation seasonally flooded (Table 3)

Table 3 Important land cover classes for fisheries, which are aggregated in the SEEA land cover classification

SEEA land cover classification	Important classes for fisheries	Surface (km2)
Artificial surface		1,709
Herbaceous crops		
	Rice fields	428
	Irrigated herbaceous crop (sugar cane)	302
	Cultivated dambos	4,008
	Other herbaceous crops	42,515
Woody crops		1,365
Grassland		1,087
Tree covered areas		36,769
Shrub covered areas		1,323
Barren land		207
Shrubs and/or herbaceous vegetation, aquatic or regularly flooded		4,322
Inland water bodies		
	Lakes	1,313
	Artificial reservoir	4
	Rivers	90
TOTAL LAND AREA		**95,347**
lake Malawi		**22,009**
TOTAL COUNTRY AREA		**117,356**

The major issue of using the Atlas of Malawi to derive the extent of water resources in the country is that lake Malawi, which has an estimated surface between 22,000 -25,000 km^2, is not included in the land cover map. This is because the Atlas is meant to depict the characteristics of the land area. Although the Atlas of Malawi has several classes describing water areas, these classes are only screened within the extent of the land area. In the Atlas interpretation, Lake Malawi is assimilated to an internal sea. This interpretation is supported and reinforced by the fact that neither the watershed-level neither the district-level include the area of Lake Malawi.

Geographically the definition the watershed is defined as an area, which collects water and drains it to a single outlet. In the watershed surrounding Lake Malawi the outlet point is located where the main river discharges water into Lake Malawi. Thus, the watershed boundaries lies at the edge of the Lake Malawi and will not include any portion of the open water of the lake.

Also the administrative boundaries of the districts surrounding Lake Malawi lie at the edge of Lake Malawi, which is administratively considered a national area.

In order to overcome this fact and provide a better integration of land and water data two approaches are suggested. The choice of the approach will be influenced by the final scope of the analysis:

1. **APPROACH => Considering only water categories.**

When the scope is to characterize important fishing areas, the straightforward approach is to consider only water categories and provide estimates of the surface of these existing water resources.

1a. If countries do not have major lakes, then a fine-resolution land cover map can be used to estimate the surface of existing water resources.

1b. If countries have major lakes, then a fine-resolution land cover map should be used in conjunction with other ancillary information to be able to estimate the surface of existing water resources.

2. **APPROACH => Comparing water and land categories**

When the scope is to compare the extent of water resources with the extent of other type of land cover classes and the analyzed country is characterized by major lakes (see 1b), then the straightforward approach is to merge all the watersheds or the district surrounding the major lake into one unit.

Table 4 Extent of different land cover classes in different watersheds (km^2)

SEEA land cover classification	Important classes for fisheries	LAKE CHILWA watershed	LAKE CHIUTA watershed	RUO watershed	SHIRE watershed	watersheds surrounding LAKE MALAWI	TOTAL
Artificial surface		174	64	133	615	723	1,709
Herbaceous crops							
	Rice fields	125	15	12	34	242	428
	Irrigated herbaceous crop (sugar cane)	0	0	0	191	111	302
	Cultivated dambos	536	303	318	741	2,110	4,008
	Other herbaceous crops	2,593	1,417	2,006	8,743	27,756	42,516
Woody crops		17	38	412	58	838	1,365
Grassland		62	0	77	124	824	1,087
Tree covered areas		432	491	318	7,451	28,078	36,769
Shrub covered areas		1	13	10	206	1,093	1,323
Barren land		20	8	63	16	99	207
Shrubs and/or herbaceous vegetation, aquatic or regularly flooded		724	221	6	611	2,761	4,322
Inland water bodies							
	Lakes	1,005	56	1	27	22,138	23,227
	Artificial reservoir	0	0	0	0	4	4
	Rivers	0	0	8	65	17	91
TOTAL COUNTRY AREA							117,356

SECTION 2 - SEEA WATER ACCOUNT

The aim of the water asset account is to report all water resources within the national territory that can provide direct use benefits now or in the future (option benefits) through the provision of raw material and that may be subject to quantitative depletion through human use.

2. 1 WATER ASSET ACCOUNT IN THE SEEA – PHYSICAL UNIT

The structure of the physical water asset SEEA water account consists in an account of water flow recorded at the beginning and at the end of the accounting period (closing stock of water resources).
The amount of water resources measured in cubic meters at the beginning of the accounting period (opening stock of water resources) are summed to the 'total of additions to stock', which can be caused by natural process and by human activities, and is subtracted to the 'total of reduction to stock' which also can be affected by natural process and by human activities (Table 5.11.2 page 198).
In this asset account there is no breaking-down of the information regarding the different type of activities for which water is abstracted (irrigation, industrial, domestic, aquaculture, etc.). The analysis and comparison amongst sectors is specifically described within another type of account (the supply-use table). However, the total of abstracted water reported into this account should be the same as the sum of abstracted water by sector further described in the supply-use account. Thus, information about the abstraction, consumption and returned by each sector is implicitly required for the correct compilation of the account.
The aim of the SEEA physical asset account for water resources (m^3) is to assess how changes in the asset accounts due to human activities (i.e. abstraction and returns) **affect the existing water stocks.**

Table 5 Physical asset account for water resources (m^3)

	SURFACE WATER			GROUND WATER	SOIL WATER	TOTAL
	Lakes	Rivers	Reservoirs			
Opening stock of water resources						
Additions to stock						
Returns						
Precipitation						
Inflow from other territories						
Inflow from other inland water resources						
Discoveries of water in aquifers						
TOTAL additions to stock						
Reduction to stock						
Abstraction						
Evaporation and actual						

evapotranspiration						
Outflow from other territories						
Outflow to the sea						
Outflow to other inland water resources						
TOTAL reductions in stock						
Closing stock of water resources						

2.2 GUIDELINES FOR IMPLEMENTATION OF SEEA WATER ACCOUNT

There are three main issues to take into consideration for the implementation of physical asset account for water resources

1. Physical asset account for water should reflect the fact that fluxes are more important than stocks;
2. Surface water, groundwater and soil water are inter-dependent;
3. Changes in stock can be related to natural process and/or by human activities
4. Changes in stock due to human activities should measure both withdrawals and returns

2.2.1 The importance of considering water flows rather than stocks

While the concept of variation in stocks recorded at the beginning and at the end of the accounting period well applies to asset such as timber, soil resources, forest and wooded areas, the dynamic nature of water makes requires taking into consideration flows rather than stocks.

This implies to consider water flow within its hydrological cycle and recognize that the flow of surface water, ground water and soil water are interdependent. In fact, the amount of water entering in a country through endogenous precipitations will determine the water contained in the soil, which in turns will determine both the flow of surface water (i.e. runoff) and the water flow which will reach the groundwater.

In particular, the dynamic nature of water will make difficult to isolate in national accounts the component of soil water given that this consist of soil moisture retained in the uppermost belt of soil, which can evaporate, can be absorbed by the plant roots and later evapo-transpirates through the leaves, can percolate into the soil and reach the aquifers or be part of water runoff and be drained into rivers or other water bodies.

The soil type and soil characteristics as well as land cover will highly influence the amount of soil water and the direction and type of flow that will be recorded. Thus, the soil water will vary spatially and temporarily and will be very difficult to measure overall soil moisture at national scale and on a year basis as a figure to be reported in a SEEA account.

Moreover, it can be considered that soil moisture is usually a compartment in which water is retained for relatively short time and it is mostly the intermediate compartment between surface water and groundwater.

2.2.2 SEEA water account and the water flows related to natural process

It is possible to compile SEEA water account by **FAO AQUASTAT database[1].**

AQUASTAT contains standardized tables of key statistics for 150 countries (developing and in transition), which are compiled and reviewed every 5 year through:

a) Country based reviews of existing literature;

b) Data and information collection by national resource person's trough a detailed questionnaire;

c) Critical analysis, data processing, and standardization of information;

d) Preparation of country profiles and tables, which are submitted to national authorities for feedback and approval before being disseminated.

In particular, in the **AQUASTAT country profiles,** there are key variables that can be used in the compilation of the SEEA water account (Table 3).

The SEEA water account has separate categories for natural water inflows and natural water outflows. However, the precipitations and evaporation/evapotranspiration are already considered within the Internal Renewable Water Resources (IRWR) metric, which expresses the average annual flow of rivers and recharge of aquifers generated from endogenous precipitation. So by using AQUASTAT data the SEEA water account can be simplified by considering the Internal Renewable Water Resources (IRWR) together with the water inflow and the water outflow to other territories.

Table 6 Relationship between SEEA water flows related to natural processes and AQUASTAT

	SURFACE WATER	GROUND WATER	TOTAL
Opening stock of water resources			
Additions to stock			
Returns			
Total Internal Renewable Water Resources (IRWR)	Surface water produced internally	Internal groundwater recharge	= Surface water produced internally + 'Internal groundwater recharge' - Overlap '
Inflow from other territories	Surface water entering the country - inflow submitted to treaties	Groundwater entering the country taking into consideration eventual treaties (*)	
TOTAL additions to stock			
Reduction to stock			
Abstraction			
Outflow from other territories	Surface water leaving the country - outflow submitted to treaties	Groundwater leaving the country (*)	
Outflow to the sea			

[1] The description of the AQUASTAT variables is heavily drawn from the description made by Margat *et al.* (2005)

TOTAL reductions in stock			
Closing stock of water resources			

(*) These amounts are more theoretical as in practice is very difficult to have data on these water flows

When there is no need to have distinct information on the water inflow and the water outflow to other territories, it is also possible to implement even a more simplified version of the SEEA account table. In this case the Total Renewable Water Resources (TRWR) metric is used as a synthetic measure of hydrological water flows due to natural process. TRWR combines precipitations, evaporation and evapotranspiration, inflows and outflows from other territories and expresses the yearly amount of water actually available for a country.

Technically TRWR is the sum of the Total Internal Renewable Water Resources (IRWR), and the Total External Renewable Water Resources (ERWR).

IRWR is the sum of the surface water produced internally and the groundwater produced internally minus the water flow exchanges occurring from surface water to groundwater and vice versa due respectively to seepage and drainage.

$$IRWR = R + I - (Q_{OUT} - Q_{IN})$$

where:

R = surface runoff, which is the total volume of the long-term average annual flow of surface water generated by direct runoff from endogenous precipitation

I = groundwater recharge, generated from precipitation within the country

Q_{OUT} = groundwater drainage into rivers (typically, base flow of rivers)

Q_{IN} = seepage from rivers into aquifers

The External Renewable Water Resources (ERWR) takes into account the amount of the country's annual renewable water resources that are not generated in the country.

When assessing the external flow of a country (ERWR), AQUASTAT distinguishes between natural flow and actual incoming flow:

Natural inflow (ERWR _natural) is the average annual amount of water that would flow into a country in natural conditions, i.e. without human influence;

$ERWR_{NATURAL} = SW_{IN} + SW_{PR} + SW_{PL} + GW_{IN}$ (Equation 2)

where:

SW_{IN} = surface water entering the country
SW_{PR} = accounted flow of border rivers
SW_{PL} = accounted part of shared lakes
GW_{IN} = groundwater entering the country

While Actual inflow (ERWR _actual) is the average annual quantity of water entering the country, taking into account that part of the flow which is secured through treaties or agreements (in upstream and downstream countries) and possible water abstraction in upstream countries.

$ERWR_{ACTUAL} = SW^{1}_{IN} + SW^{2}_{IN} + SW_{PR} + SW_{PL} – SW_{OUT} + GW_{IN}$ (Equation 3)
where:

SW^{1}_{IN} = volume of surface water entering the country which is not submitted to treaties
SW^{2}_{IN} = volume of surface water entering the country which is secured through treaties
SW_{PR} = accounted flow of border rivers
SW_{PL} = accounted part of shared lakes
SW_{OUT} = volume of surface water leaving the country which is reserved by treaties for downstream countries
GW_{IN} = groundwater entering the country

Thus, depending on which metric is chosen to depict external water flow of a country (EWR natural or EWR actual), then the **Total Renewable Water Resources (TRWR) can also natural or actual**

$$TRWR_{NATURAL} = IRWR + ERWR_{NATURAL}$$

or

$$\mathbf{TRWR_{ACTUAL} = IRWR + ERWR_{ACTUAL}}$$

However it should be noted that ERWR actual is influenced by formal or informal agreements and is more likely to show variation in time, even yearly.

Given that the SEEA water account aims to provide a description on how the actual amount of available water flow in a country are affected by the current pattern of abstraction and returns, the TRWR_actual will be more pertinent measure.

When the TRWR is used as a synthetic measure to describe the water natural flow, then it will be only necessary to provide estimates for the abstraction and returns related to human activities (Table 7).

Table 7 Simplified SEEA water account by using FAOSTAT data

	SURFACE WATER	**GROUND WATER**	**TOTAL**
Opening stock of water resources			
Additions to stock			
Available water flow in the country	Surface water: total renewable (actual)	Groundwater: total renewable (actual)	Total Renewable Water Resources (TRWR) actual
Returns			
TOTAL additions to stock			
Reduction to stock			
Abstraction			
TOTAL reductions in stock			
Closing stock of water resources			

2.2.3 The potential of GIS-based water balance model to assess SEEA water account

FAO has also implemented a GIS-based global water balance model for every country, which can be used for SEEA water asset**.**

The model combines together available datasets related to climatic variables (resolution 10 arc minutes) and terrain and land cover dataset (resolution 5 arc minutes). This model aggregates the spatial variability of different environmental conditions recorded in the country by aggregating information from the spatial unit used in the model (cell) to the water basin and finally to the country-level.

The global water balance is calculated in two steps: vertical water balance and horizontal water balance[2]. In the vertical water balance in each cell model is recorded the amount of water received by rainfall, as well as the amount of water that evaporates or evapotranspirates, the amount of water that percolates in the soil and returns to the groundwater aquifers according to the soil type recorded. In the horizontal water balance is calculated the additional amount of water that evaporates from inland water bodies or evapotranspirates from natural or cultivated vegetation as well as the water that evaporates from irrigated crops. The output of the horizontal water balance is the discharge (run-off) generated from each watershed. The national amount of surface water actually available for a country is derived by combining together the discharge of the different watershed in the country and by accounting also the inflow of water coming from neighboring countries as well as the outflow of water to neighboring countries or to the sea.

In AQUASTAT the GIS-based water balance model is particularly used to estimate the modeled irrigation water requirements, which depend on depends on the crop water requirements and the water naturally available to the crops.

However, the model can also be used for SEEA water account implementation at sub-national level with the following finalities:

- Showing seasonality of water availability by watershed
- Showing asymmetries of water flow amongst watersheds

Implementing SEEA at the watershed level can provide important information for decision making regarding periods and geographic areas that can be interested by water shortage and water conflicts (see Appendix II).

In order to provide more insight on the consequences of variation of water flow in the country a model could be useful to generate different scenarios. A GIS-based water balance model would be needed for this particular application of SEEA given that all the variables in the SEEA water account are highly interdependent. Thus, **simulations** could be carried out to show the consequences in the overall national water budget caused by:

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[2] Hoogeveen *et al.* (in prep)

- Climate change and decrease in the precipitation regime

- Changes in the amount of water inflow from neighboring countries

- Changes in the amount of water outflow to neighboring countries secured by treaties

- Increase in the irrigated cropping area or other variation in the land use

2.2.4 SEEA water account and the water flows related to human activities

The estimates of the water abstracted for different purpose such as hydropower generation, industrial, irrigation usually require more fine-grain type of information.

• Estimating withdrawals

Water withdrawals are defined as the gross volume of water abstracted from streams, aquifers or lakes for any purpose (irrigation, industrial, domestic, commercial) (FAO, 2012).

The primary data sources for withdrawals are usually

- Abstraction and supply by water supply industries
    - Census on water supply industries by NSIs
    - Data from invoicing of water supply
    - Water (supply) associations
- Water abstraction and use by other industries
    - Existing administrative data (e.g. from checking of water permits)
    - Surveys by NSIs (biggest water users and representative water users)
    - Calculation with water use factors (per unit of product / per EUR value added / per employee…)
    - Expert estimation
- Water abstraction and use by agriculture
    - Administrative data
    - Farmers Association
    - Invoicing data
    - Agriculture statistics
    - Expert calculations
- Water abstraction and use by households
    - Household census and water use factors
    -

AQUASTAT contains data for withdrawals for the following classes:

- Irrigation and Livestock
- Municipalities
- Industry

Information related to withdrawals is reported from the countries.

Presently there is no estimate of water withdrawals for aquaculture. Although this is usually a negligible part within the overall withdrawals for agriculture, it would be advisable to insert it to represent the sector within the other stakeholders.

• Estimating the return flow

In the SEEA water account the amount of water abstracted for a given purpose should be accounted together with the amount of abstracted water which is returned to the environment.

The returns are defined as the total volume of water that is returned to the environment by economic units into surface, soil and groundwater during the accounting period. Each sector can withdraw some water from existing water resources needed to support its economic activities; this water can be temporarily stored for sector usage and later released in the environment.

Some sectors make in-stream water use of surface water resources, which means that there is not withdrawal, but the use is provided directly in the river or lake in question.

The in-stream water use can be reported in the SEEA table by estimating the overall amount of in-stream water flow used by the sector and by considering withdrawals equals to returns**.**

For all the other sectors that don't have an in-stream water use, water withdrawals do not equal the returns. The difference is due to the amount of water that is lost due to evaporation. The difference between withdrawals and returns is acknowledged as 'Consumptive water use' (FAO, 2012).

2.2.5 SEEA water account unresolved issues for fisheries

The SEEA water account has several limitations to describe the water requirements for the inland capture fisheries and aquaculture sector.

SEEA water accounts describe water stocks and water flows both measured in water volumes. However,

• Water volumes related both to water stocks and water flows do not represent well fish habitats;

• It is difficult to provide estimate of the environmental flow needed to sustain ecosystem process and the natural water cycle in the country;

• Inland capture fisheries and aquaculture are greatly influenced by the seasonal variation of water flow and to the occurrence of natural overflowing of rivers and formation of seasonally flooded areas;

• Inland capture fisheries and aquaculture are highly affected by the level of fragmentation and the degree of flow regulation of the river systems;

• Local sub-national variation of water resources and water use abstractions could be relevant and are definitely critical in water and fishery management.

APPENDIX

EXAMPLE OF SEEA WATER ACCOUNT IN MALAWI AT NATIONAL LEVEL

The SEEA water account is essentially a hydrological account of water flows in the country generated by climatic conditions and soil and land cover on one side and the water use pattern (withdrawals and returns) by human activities.

The SEEA water account is composed of an initial evaluation of water stocks that are accounted in the opening stocks, an analysis of water flows both as additions and reductions and a final assessment of closing stocks.

Table 8 Implementation of SEEA water account with AQUASTAT data

Physical units (10^6 m^3/yr)	SURFACE WATER	GROUND WATER	TOTAL
Opening stock of water resources			
Additions to stock			
Returns	*No data*		
Total Internal Renewable Water Resources (IRWR)	16140	2.4	16.14[3]
Inflow from other territories- Rue River	1000		
Inflow from other territories – lake Mozambique border	140		
TOTAL additions to stock	17280		
Reduction to stock			
Withdrawal (irrigation and livestock)	810		
Withdrawal (municipalities)	148		
Withdrawal (industry)	47		
TOTAL reductions in stock	1005		
Closing stock of water resources			

Overlap between surface water and groundwater is 2.4 (10^9 m3/yr)

Thus, in the account there are two components: a statistic one constituted by water stocks which can be increased/decreased by the additions/reductions of the dynamic component constituted by water flows.

3

At the moment there is no direct linkage between the stocks of water and the flows of water.

Since fish live both in lakes and other water bodies as well as rivers and seasonally flooded areas, inland capture fisheries and aquaculture are influenced both by a variation of water stocks and water flows.

The GIS-based water balance model focuses on water flow and does not account for water stocks. The model in fact does not consider the real water volumes of existing water resources, which are considered as water areas of about 1 meter depth.

AQUASTAT reports both the volumes of major water bodies in Malawi and the main water flows. In particular, there are available data describing the water flow related to natural processes, Internal Renewable Water Resources (IRWR) and Total Renewable Water Resources (TRWR). However, the water accounting of reductions to stock is not complete as there are no data for water returns. Water returns should be estimated or the lack of data will translate into the fact that the whole withdrawals would be considered as consumptive use.

At the moment the available data in AQUASTAT allow for a valuation of water flow in the country but there is no direct linkage on how the variation of water flow will translate into a variation of water stocks.

As a theoretical example a country could have a relative high amount of seasonally water run-off during the wet season, but if this water is collected in very shallow lakes or rivers or evaporates for great part during the dry seasons, the recorded run-offs could be not enough to establish permanent suitable fish habitats.

At the same time the whole amount of surface run-off could not be considered as fish habitats as the total surface water run-offs includes not only the water flowing in the rivers and the water that is seasonally flooded from the rivers to the surrounding plains, but also the film of water that is accumulated on the soil and that later returns to the hydrological network.

Despite the fact that in Africa Malawi is considered a water rich country and the large amount of Total actual Renewable Water Resources (TRWR) recorded on a year basis, water flow in the country record a strong fluctuations both amongst years and seasons.

The climate of Malawi is tropical, but the influence of its high elevation means that temperatures are relatively cool. Year-to-year variability in rainfall is very strong in Malawi and this can make it difficult to identify long term trends. This is due to the fact that the country is influenced by Indian Ocean Sea Surface Temperatures, which can vary from one year to another due to variations in patterns of atmospheric and oceanic circulation. In particular, El Nino and Southern Oscillation (ENSO) highly influence the regimes of the precipitations in Africa. Under El Niño conditions Eastern equatorial Africa tends to receive above average rainfall, while south-eastern Africa often experiences below average rainfall. The opposite response pattern occurs in La Niña

episodes. Given that Malawi is located in between these two regions of opposing climatic responses, often mixed responses are recorded (McSweeney *et al*., nodate).
Aquastat reports an average precipitation in the country of 1181 mm/year.
An assessment of the average precipitation recorded in 27 meteorological stations in Malawi between 1976 and 2000 (Fig. 1) shows that in some years such as 1977, 1992 and 1994 the country average recorded rainfall was around 800 mm/year or below. On the contrary, in 1978, 1989 and 1993 the country average recorded rainfall was between 1300-1350 mm/year.
This shows how the country is prone to droughts and floods events.

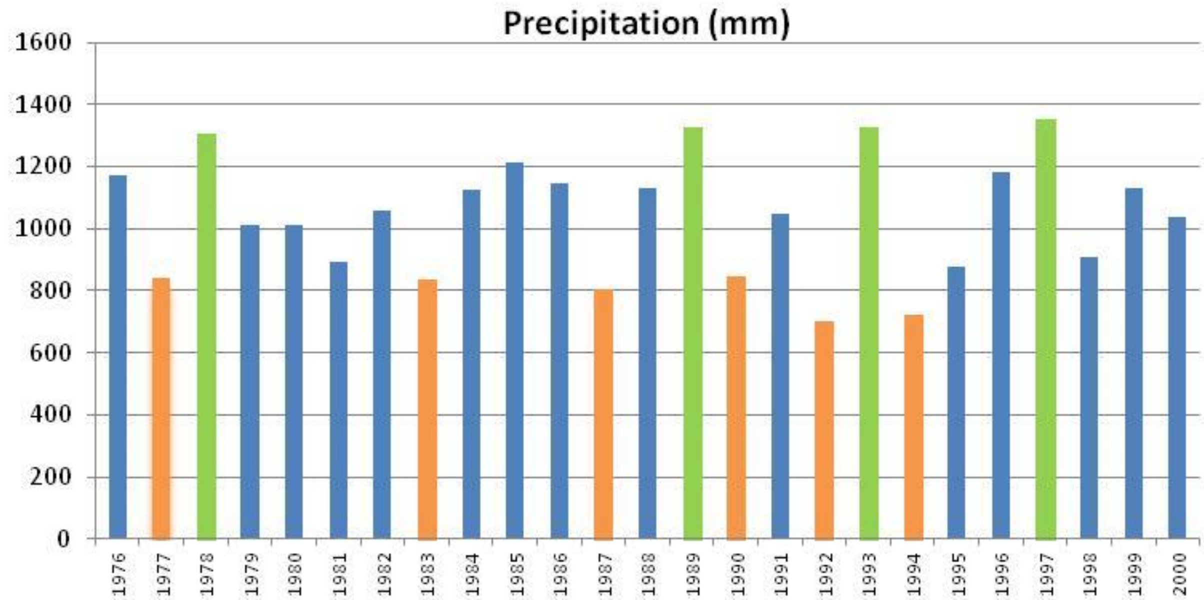

Fig. 1 Average annual precipitation computed from average monthly precipitations recorded in 27 meteorological stations in the country (data provided by the University of Malawi- Dep. Geography and Earth Science).

This implies that in the implementation of SEEA water account, it would be recommended to provide scenarios of the amount of the Total Actual Renewable Water Resources in a case of years of droughts as well as years of flood events.

- **Importance of seasonality of water flow at the watershed level**

Malawi is characterized by seasonal rainfall, which largely occurs during the summer months November to April (Figure 2, *a*). Thus, it is of interest to assess the surface run-offs that is generated monthly in the different watersheds.

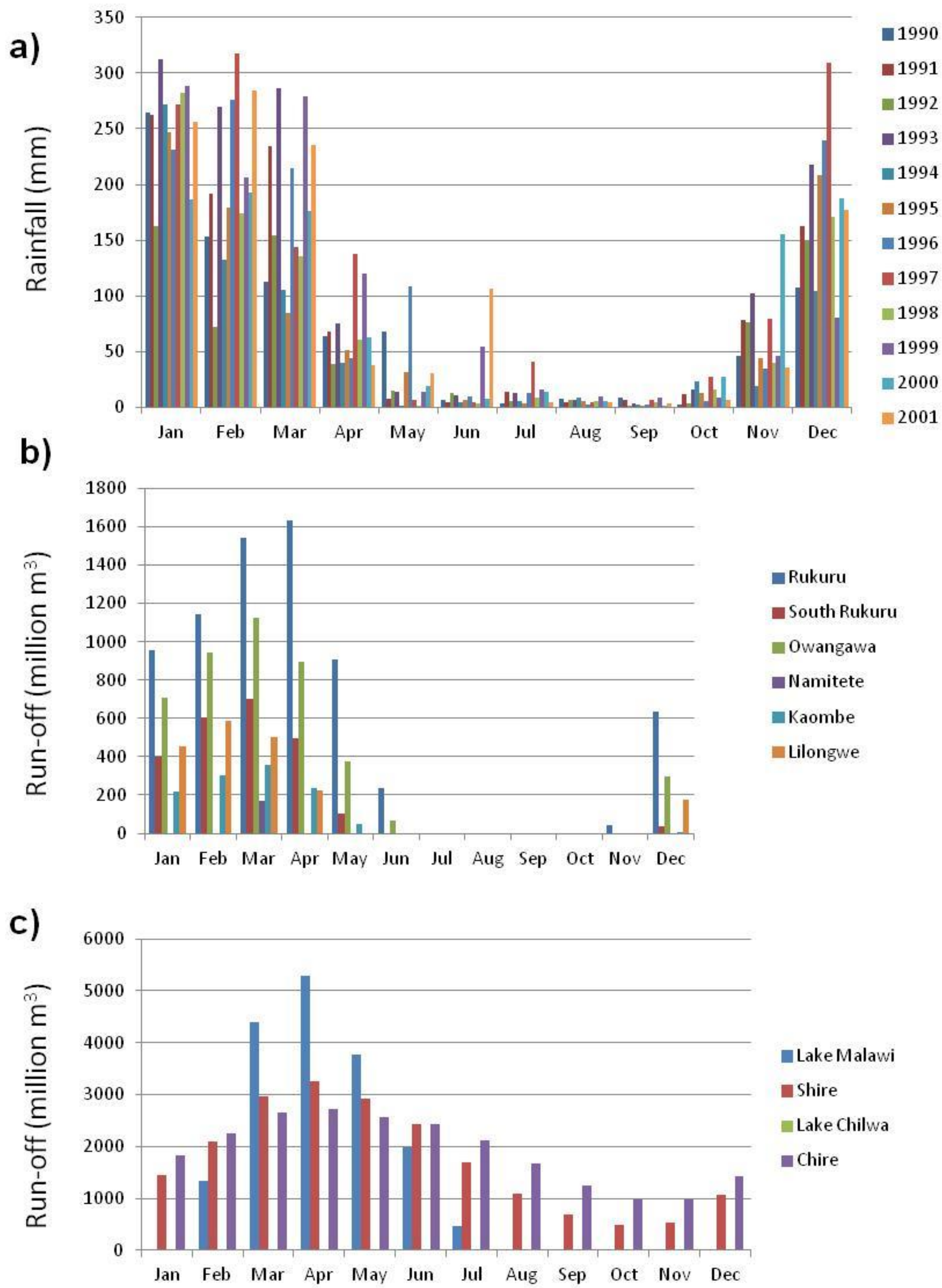

Fig. 2 Average seasonal variation of precipitations recorded monthly between1990-2001 (a) and monthly surface run-offs generated in watersheds around Lake Malawi (b) and in watersheds that are fed by the Shire River originated from Lake Malawi and Chire River (c)

For this purpose, the modeled surface run-offs carried out by the GIS-based global water balance model (Hoogeveen *et al.*, in prep) were extracted at the watershed level.
In particular, watersheds were divided in two geographical areas. The first group aggregates watersheds that are around Lake Malawi and whose major rivers such as the North and South Rukuru, Dwangwa River, Lilongwe River and Bua Rivers that feed Lake Malawi. The second group consists of three watersheds that are located south and east of Lake Malawi.
It is interesting to note that the modeled surface run-offs during the dry season is null in the watersheds that feed Lake Malawi and this causes also in a decrease of water flow in the Lake Malawi as well. The water flow of the Shire River that is the only outlet of Lake Malawi is also affected by a seasonality pattern.

Table 9 Different estimates of the water flow of the Shire River

Source	**Year**	**Annual (m^3)**	**Dry season (m^3)**	**Wet season (m^3)**
AQUASTAT	Nodate	400		
Shela (2000)	1991	500	360	550
Hoogeveen *et al.(in prep)*				

While the data reported in AQUASTAT for the Shire River (400 m^3) is similar to the value reported in 1991 by Shela (2000), it is interesting to note that there is a variation recorded in the dry and the wet season. It is difficult to compare the value reported by Shela (2000) with the surface run-offs modeled by the GIS-based global water balance as the computed average will be highly affected by which and how many months are included in the dry and wet season.
However, the minimum water flow recorded in the Shire watershed as modeled by the GIS-based global water balance is found in the month of October, which records a water flow of 485 mm.
A variation amongst years between the dry and wet seasons is also expected. However, it is worth to know that in 1997 an annual water flow of 130 m^3 hampered the functioning of the power plants on the Shire River.
Similarly there might be threshold value of water flow in some watersheds that hampered the environmental water flow necessary to sustain inland capture fisheries and aquaculture.

SECTION 3 - SEEA FISH ACCOUNT

3. 1 FISH ACCOUNT IN THE SEEA – PHYSICAL UNIT

The fish asset table in physical units (Table 10) accounts for the fish (number or weight) at the beginning of the accounting period plus natural growth, minus fish (number or weight) harvested and minus natural death. As for the other assets, the aim of the fish asset table is to distinguish between a decrease in the existing stock due to unsustainable gross catch (i.e. depletion) from a decrease due to natural demographic process (i.e. normal losses) from a decrease due to adverse environmental factors or habitat degradation (i.e. catastrophic losses).

Table 10 Structure of the SEEA fish asset account in physical units

FISH ASSET	Marine fisheries (tonnes)	Inland capture fisheries (tonnes)	Aquaculture (tonnes)
Opening stock			
Additions to stock			
Natural growth			
Reduction to stock			
Gross catch			
Normal losses (*)			
Catastrophic losses (*)			
Estimated discard at harvest			
Closing stock			

(*) these categories are usually aggregated in a generic category 'Other changes in volume' FAO (2004).

Usually fishery statistics report the yearly amount of fish harvested. In few cases fisheries surveys can convey also information on average estimated discard at harvest and catastrophic losses.

It is relevant to note that fish asset account only deal with the first segment of the food production chain (i.e. fish harvest). All eventual loss related to the processing activities and assemblages of fish products should not be included in the fish asset account.

Usually the distinction between natural mortality and other changes in the amount of fish stock cannot be determined with certainty, thus a simplified version of the fish asset account table (Table 11) distinguishes only between reductions due to gross catch and other change in volume (FAO, 2004).

Table 11 Simplified SEEA fish asset account in physical units

FISHERIES CHARACTERISTICS	NON-CULTIVATED AQUATIC RESOURCES		CULTIVATED AQUATIC RESOURCES
	Marine fisheries (tonnes)	**Inland capture fisheries (tonnes)**	**Aquaculture (tonnes)**
Opening stock			
Catch			
Other change in volume of assets			
Closing stock			

However, without information on the stock size at the beginning of the accounting year (i.e. opening stock) the account table cannot establish if the recorded reduction to stocks due to harvest constitute a sustainable fishing quota. In particular, sustainability could be achieved if the fish stock would be exploited only at the natural rate of fish stock net growth (FAO, 2004).

3.2 GUIDELINES FOR IMPLEMENTATION OF FISH ASSET ACCOUNTS

There are four main issues to take into consideration for the implementation of fish asset account:

1. Fish stock size are crucial as a reference point to evaluate the amount of fish harvested
2. Estimates of fish stocks often have often low accuracy and should be used with caution;
3. Estimates of fish stocks are usually carried out at species-level;
4. Multi-species stock can be evaluated indirectly by monitoring catch trends and fishing effort in time

3.2.1 Challenges of estimating fish stock

Estimating the fish stock is the most critical part of compiling the fish asset table and requires the:

- Identification and definition of the fish stock
- The use of a model able to extrapolate the (unknown) fish stock size from information related to the known amount of fish harvest and fishing effort

Estimating the fish stock size is not a straightforward task and there is no agreed methodology on this issue and still major methodological gaps remain on ‘what to measure’ as well as ‘how to measure’.

Ideally the SEEA fish asset account should be compiled for individual species as the information related to additions and reductions to stocks essentially refer demographic parameters (natural growth and natural mortality), which is combined with information on the fish harvest.

When the SEEA fish asset account is compiled for individual species, then it might be possible to use statistical model to estimate the size of the stock at the beginning of the accounting period. For example the Norway Institute of Marine Research provide estimates of stock size for the major commercial species (e.g. North-artic cod) in order to provide background information on fisheries management (FAO, 2004).

However, fish stocks are usually a sub-set unit of one species. In fact, fish stock refers to a population having the same growth and mortality parameters, and inhabiting a particular geographical area (FAO, 2007). As an example, fish stocks assessed by the Norway Institute of Marine Research refer also to an identified geographical area (i.e. Capelin in the Barents Sea or North artic cod).

In reality, compiling SEEA fish asset account for individual species might be impracticable not only for the lack of data, but also for the high number of fish species that are exploited in tropical marine and inland fisheries.

In most cases the SEEA fish asset account will be compiled for aggregated fish species. In this case, the only way to assess if fishing activity in a country is carried out is to monitor its trend in time. If the trend is stable across years and a similar amount of catch per unit effort is fished every year, theoretically it can be assumed that the fishing activity is not depleting the existing fish stock. In reality, since SEEA fish asset account is compiled for multi-species the composition in species of the catch would be key information to ensure that, despite the same amount of fish landed, some fish stocks have not been exploited and replaced by other more abundant fish species.

3.2.2 Diversity of the fishery sector and challenges of estimating fishing effort

Table 12 describes major different attributes which usually characterise marine fisheries, inland capture fisheries and aquaculture.

Table 12 Different characteristics of marine fisheries, inland capture fisheries and aquaculture

FISHERIES CHARACTERISTICS	Marine fisheries (tonnes)		Inland capture fisheries (tonnes)			Aquaculture (tonnes)	
	Commercial	**Artisanal**	**Commercial**	**Artisanal**	**Subsistence**	**Commercial**	**Artisanal**
Aquatic resources	Natural					Cultivated	
Fishery target species	Few species	Multi-species	Few species	Multi-species		Few species	Few species
Fish communities	Marine and brackish species		Freshwater, brackish and diadromous species			Freshwater, brackish, marine	Freshwater
Fish stock	Are found in broadly defined marine areas		Are found in different well-distinct water bodies			Are found in enclosed artificial/natural waters	

Employment	Recorded	Recorded/Un-recorded	Recorded	Recorded/Un-recorded	Un-recorded	Recorded	Recorded/Un-recorded
Fishing vessels and fishing boats	Recorded	Recorded/Un-recorded	Recorded	Recorded/Un-recorded	Un-recorded		
Fishing license/permit	In place	In place/absent	In place	In place/absent	Absent		

A first consideration is that a distinction should be always made between commercial and artisanal fisheries. Activities carried out by commercial fisheries might be easier to monitor and quantify the harvested fish stock as well as fishing effort.

In particular, commercial fisheries usually target few fish species of high commercial value, they are requested to report fish catch (i.e. catch retained by species and catch discarded by species) in logbooks, they also requested to provide landings declarations (i.e. quantity of each species normally subject to catch quotas or other regulations) and sales notes. Moreover, the number of employed in commercial fisheries and the hours spent at sea are usually recorded as well as fishing vessels. Thus, data on gross catch as well as fishing effort is relatively easy information to collect, although misreporting can still occur.

Similarly, SEEA fish asset account for aquaculture information is relative straightforward because stocks are raised in artificial environments which are relatively easy to control and monitor. However, commercial aquaculture is likely to provide more robust data than artisanal aquaculture especially when aquaculture is carried out as an integrated household livelihood strategy.

The major challenge for the implementation of the SEEA fish asset account remains for the artisanal fisheries (both marine and inland) as their harvest is usually composed of multi-species yield. The species-composition of the basket of artisanal fishermen is influenced by different factors such as demographic factors related to the status of the fish stocks, environmental factors related to the fishing conditions and fishing characteristics related mostly to the used fishing gears and fishing techniques.

At national level artisanal fishery is not always well characterised as it is constituted by large number of fishermen which operate at small-scale, often using labour-intensive fishing techniques. Artisanal fishermen often have non-motorised boats, which do not require registration and they land their catch in small landing places and harbours or directly at beach. A share of the catch is often used for fish consumption and constitutes a “hidden harvest” as this catch is not registered within market transactions. Some fishermen are not professional fishermen, but they fish for subsistence on a part-time or even seasonal/occasional basis, while earning most of their income from agriculture and other related activities.

The characteristics of artisanal fishery make very difficult to assess and quantify fishing efforts, unless specific field survey are carried out.

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GLOSSARY

Aquatic resources: include fish, crustaceans, mollusks, shellfish and other aquatic organisms such as sponges and seaweed, as well as aquatic mammals such as whales (par. 5.393 page 183).

Artificial reservoirs: are purpose built reservoirs used for storage, regulation and control of water resources (EU *et al.* 2012: par. 5.479 page 196).

Consumptive use of water: is the part of water withdrawn from its source for use in a specific sector (e.g. for agriculture, industry or domestic purposes) that will not become available for re-use because of evaporation, transpiration, incorporation into products, drainage directly to the sea or evaporation areas, or removal in other ways from freshwater sources. The part of water withdrawn that is not consumed in these processes is called return flow (FAO, 2012).

Fish stock or fish resource: are defined as the living resources in the community or population from which catches are taken in a fishery. Use of the term fish stock usually implies that the particular population is more or less isolated from other stocks of the same species and hence self-sustaining (FAO, 1997).

Glaciers: are defined as an accumulation of snow of atmospheric origin, generally moving slowly on land over a long period (EU *et al.* 2012: par. 5.479 page 196).

Internal Renewable Water Resource is that part of the water resources, surface water and groundwater, generated from endogenous precipitation

Lakes: are in general, large bodies of standing water occupying a depression in the earth's surface (EU *et al.* 2012: par. 5.479 page 196).

Land use for aquaculture: is the land used for aquaculture facilities and fish farming activities. Aquaculture refers to the farming of aquatic organisms: fish, molluscs, crustaceans, aquatic plants, crocodiles, alligators, turtles, and amphibians. Farming implying some form of intervention in the rearing process to enhance production, such as regular stocking, feeding, protection from predators, etc. (EU *et al.* 2012: par. 1.3 page 270).

Rivers and streams: are bodies of water flowing continuously or periodically in channels (EU *et al.* 2012: par. 5.479 page 196).

Soil water: consists of water suspended in the uppermost belt of soil, or in the zone of aeration near the ground surface. Soil water can be discharged into the atmosphere by evapotranspiration (i.e. the quantity of water transferred from the soil to the atmosphere by evaporation and plant transpiration), be absorbed by plants, flow to groundwater, or flow to rivers (run-off). Some part of transpiration and absorption of water by plants is used in production (e.g. the growing of crops). (EU *et al.* 2012: par. 5.482 page 197).

Snow and ice: include permanent and seasonal layers of snow and ice on the ground surface (EU *et al.* 2012: par. 5.479 page 196).

The inland water system comprises surface water (rivers, lakes, artificial reservoirs, snow, ice, glaciers), groundwater and soil water within the territory of reference (EU *et al.* 2012: par. 3.187 page 68).

Wastewater is discarded water that is no longer required by the owner or user. Water discharged into drains or sewers, water received by water treatment plants and water discharged direct to the environment is all considered wastewater. Wastewater includes return flows of water which are flows of water direct to the environment, with or without treatment. All water is included regardless of the quality of the water, including returns from hydro-electric power generators (EU *et al.* 2012: par. 3.86 page 51).

Water withdrawal are defined as the gross volume of water abstracted from streams, aquifers or lakes for any purpose (irrigation, industrial, domestic, commercial) (FAO, 2012)

Water abstraction is the amount of water removed from any source, either permanently or temporarily in a given period of time. (EU *et al.* 2012: par. 5.489 page 199).

Water returns is the total volume of water that is returned to the environment by economic units into surface, soil and groundwater during the accounting period (EU *et al.* 2012: par. 5.488 page 198).