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Results and lessons from implementing the Water Assets Accounts in the EEA area

From concept to production

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European Environment Agency

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Contents

Acknowledgements 4
1 Executive summary 5

The full report and annexes are available at:
http://www.eea.europa.eu/publications/water-assets-accounts-report

Acknowledgements

These are the first EU-level water accounts that display water balances at monthly and sub-basin levels. The accounts were developed in the hope that the many data gaps and methodological imperfections will be ironed out in the future.

These accounts are the result of extensive collaboration over many years with a number of pioneers in the field of environmental accounting. Without their expertise, commitment and generosity this first work would never have been completed.

Among these pioneers, there are three people whose help was especially important. They are: the renowned hydrologist Jean Margat, who many decades ago advanced the then-controversial idea that water resources could be accounted for; Professor Michel Meybeck, who during his research and teaching career taught that applied science supported by rigorous methodology was a natural progression from fundamental research; and Jean-Louis Weber, who has worked tirelessly to promote the use of environmental accounting as a key element of environmental assessment and policy support.

This report has been prepared by Philippe Crouzet (EEA project manager) with contribution from Guillaume le Gall (Pöyry), Paul Campling (Vito), Miriam Basso (SCM) and the EEA staff members: Jean-Louis Weber, Oscar Gomez and Blaz Kurnik.

1 Executive summary

1.1 Scope of the project

The United Nations **System of National Accounting** (SNA) framework provides an internationally agreed methodology for national economic accounts. SNA accounts are the main source of information for the internationally comparable economic aggregates and indicators which are used to assess the economic performance of countries. Examples are gross domestic product (GDP), value added, income, consumption, economic growth rate and government deficit.

GDP is hence the best-known measure of macroeconomic activity. It has also come to be regarded as a proxy indicator for overall societal development and progress in general. However, GDP does not measure environmental sustainability or social inclusion, and these limitations need to be taken into account when using it in policy analysis and debates. The need to strengthen the data and indicators that complement GDP is increasingly recognised, and several international initiatives have been launched to address these issues. Taking stock of these, in August 2009, the European Commission adopted a communication 'GDP and beyond — measuring progress in a changing world' (EC, 2009). This communication explicitly addresses the need for environmental accounting (Section 3.5) and recalls that since 2006, the Commission had called on the European Union (EU) and its Member States to 'extend the national accounts to key aspects of Sustainable Development. The national accounts will therefore be complemented with integrated environmental-economic accounting that provides data that are fully consistent'. The development of the accounts is eagerly anticipated, since 'in the longer term it is expected that more integrated environmental, social and economic accounting will provide the basis for new top-level indicators'.

From 2000, the EEA has experimented with the computation of water accounting (EEA, 2001a, 2001b and 2001c) to test river quality accounting and analyse highly significant indicators. These developments were based on principles, established in the mid 1980s (Weber, 1986); the hydrologically based improvements were tested in a couple of countries only, with France being one of these (Babillot, 1995).

Building hydrologically consistent water accounting to usefully address the balance between resource and uses is a very complex task. Here, the resource is the water that can be exploited by the economy at a certain place in the catchment at a certain moment in time and uses the actual abstractions, evaporation and returns in the same place at the same time. However, and even if the needs for maintaining ecosystem functions are set aside for simplifying the approach, it is not possible to estimate the resource as the sum of volumes of water in the different compartments because the intrinsic specificities of the water pathways (water flows through rivers, exchanges between soil and underground systems, multiple uses of water along a river, etc.) on the one hand and the uses as the simple sum of abstracted volumes on the other hand. At the end, there can be 'competition' between resource and uses which identification requires appropriate methodology and data to mitigate uncertainties if information and gaps in knowledge.

Following the fundamentals developed from the mid 80s and supported by different policies related to biodiversity (e.g. the EU 2010 strategy and the Millennium Ecosystem Assessment), the physical accounts were developed by the EEA with the intention of addressing new challenges and their computation carried out to check the effectiveness of the approach and the appropriateness of the existing data collection systems. .

The development of the economic analysis of the relationships between ecosystems and biodiversity (The Economics of Ecosystems and Biodiversity (TEEB)) increased ambitions of contributing to the preservation of ecosystem and natural services in the long term, by including them in the economic framework: 'Being spatially explicit is important in order to take into account the spatial heterogeneity of service flows and of the economic values that can be assigned to them … It also allows the identification of mismatches of scales as well as analysing the distributional implications of decisions that affect ecosystems and exploring trade-offs' (de Groot et al., 2010).

These two complementary views of the Commission and TEEB reinforce the approach used by the European Environment Agency (EEA), with the active support of the Directorate-General for the Environment (DG Environment). This approach aims at being spatially explicit, so as to accurately cover the reality of systems with their physical constraints, as well as appropriately timed, so that policy-relevant information can make use of seasonal effects and time-trends. These are also the requirements for building useful indicators; since the EEA is not exclusively focused on the production of the formal accounting tables, their accounting approach targets integrated assessment capable of supporting other important environmental issues as well.

The 2012 Water Blueprint (COM/2012/0673 final) ([1]) served as an opportunity for DG Environment and the EEA to fully implement the water resource assets accounting: DG Environment hired a consultant (Poÿry) after public tendering, and the EEA provided data and information and provided technical support to the DG Environment. This report details the rationales and methodological developments that resulted, and presents two types of outcome: results proper on the one hand, and lessons in developing methodology, reference systems and data flows, on the other. The lessons point to improvements needed if water asset accounting is to form the basis for a set of 'new top-level indicators' (among other outcomes), as required by the communication mentioned above.

1.2 Main results and ancillary outcomes

Factual results and more general outcomes must be analysed under the very definition of accounting. Water accounting ([2]) is one of two ways of calculating water balances over large areas; the other is modelling. There is a fundamental difference between water accounting (and accounting for any other component of the environment as well) and modelling. Modelling is an attempt to reproduce the causal processes between different 'compartments'; accounting is placing the observations of these compartments side by side (acknowledging that the causal relationship is established), and analysing the degree to which they match.

Gaps in data sets are not expected to be reconstructed by using data from another compartment: this would breach the fundamental principle of independence of data sets in the accounting process. Hence, accounting is quite effective in identifying gaps in data sets and inconsistencies in relationships across data sets.

Consequently, the expected result is the consistency of data sets. This is a very important result since the data sets at stake are the benchmarks of policy implementation and effectiveness; the water balances, with their associated indicators, reveal the spatial and temporal structure of resources and scarcities.

The main lessons are as follows:

- Making time (month) and space (sub-basin) disaggregated water balances under the System of Environmental and Economic Accounting for Water (SEEAW) enhanced methodology is technically feasible, affordable and informative. The quality of the balance has been demonstrated (Section 5.1) to hold a direct relationship to the relevance of meteorological inputs and river discharge, that are the pillars of the accounts.

- Information resulting from the assessments clearly demonstrates that water resource issues (for uses and ecological support) are extremely diversified and significant in many EU areas, not just in structural water scarce areas; hence, they call for finely tuned policies.

- The current data flows, as collected in the EEA European Environment Information and Observation Network (Eionet) flows, were not envisaged to serve the needs of water accounting. Their restructuring requires revisions both of the networking (under the Shared Environmental Information System (SEIS)) and of internal management, to address the responsibility of data collection by universe (e.g. all relevant aspects of

([1]) Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions *A Blueprint to Safeguard Europe's Water Resources*, http://ec.europa.eu/environment/water/blueprint/index_en.htm.

([2]) In this report, the terms 'water accounts' or 'water accounting', when used without supplementary adjectives, refer to the SEEAW methodology as upgraded by the EEA in the spatial (sub-basin instead of country) and time (month instead of civil year) dimensions, and not to the simplified I/O tables derived from annual statistics.

'urban', of which urban water issues), instead of by topic (e.g. all water uses of which urban uses). The approach by topic omits certain parts of knowledge which cannot be categorised easily.

1.2.1 *Result no 1: feasibility of the asset accounts confirmed, but some data questionable*

The exercise confirmed that making assets accounts at monthly and sub-basin resolutions was feasible. This may appear to be stating the obvious, but in fact, no such exercise had ever been attempted at EU level over the past 8 years (the initial 10-year target could not be achieved).

Indeed, for this first exercise, some resources had to be mobilised with a significant share of investment in making the systematic update, as a follow-up of affordable EU policy in the current economic context.

However, this systematic update demands a rather radical revision of the data collection schemes (if it is to be affordable and effective as support to other policies); in parallel, it would significantly contribute to all EEA and Commission work (particularly by offering better data for Joint Resource Centre (JRC) modelling and forecasts).

Accounts production does not allow for delivery of figures with uncertainties; in physical accounting, it is necessary to flag results based on questionable or insufficient information. The approach taken in the reported exercise is to score the essential data sets, and compare the data scoring per sub-basin to a standard reference, indicating the median data quality that may be accepted as a short-term target for data collection.

All maps are presented with the result overlaid with a special pattern that blurs the results of the areas which quality is lower than the median quality target. For reasons detailed in methodological sections, it is not possible to monitor and calculate uncertainty; this presentation of results tells however the reader on the degree of likelihood of the results presented. By contrast, summary statistics cannot take into account such quality limitations from scoring. This is summarised in Section 1.3.

1.2.2 *Result no 2: time- and space-disaggregated indicators*

Robust, relevant and timely indicators are at the heart of high-level policy assessments and communication. However, the simpler the indicator is, the larger the precautions called for in its construction. Attempts to set up a revised Water Exploitation Index Plus (the WEI+) were less successful than expected, because of inconsistencies in the definition that resulted from the political process of setting it up, and the inappropriateness of data provided by the Member States.

Fortunately, it can be demonstrated that a wide set of hydrologically consistent indicators (the different avatars of WEI) can be directly produced from the accounts. A normalised WEI (nWEI) has been calculated, by assessing the actual water exploitation in the most comparable way. It represents the possibility for the economy to actually obtain the required water volumes, irrespective of whether they are returned. The indicators can be presented in two ways:

1. as statistical aggregates (e.g. annual averages) preserving the seasonal differences;

2. as statistical events (e.g. percentile X %), whose analysis explains the characteristics of water scarcity in structural, recurrent or episodic terms, hence opening the way to use the results for policy purposes.

Combining these indicators provides a spatially defined and statistically representative assessment of water exploitation at the European level. The results are presented from Chapter 5 onwards; fundamental findings are reported below.

Of 411 sub-basins, one half are in the interannual WEI average of less than 10 %; 57 (14 %) could not be computed owing to lack of essential data, in this case only outlet information. This means that at least half of the sub-basins are not under systematic water scarcity threat.

By contrast, 87 sub-basins are in the 10 % to 25 % range, meaning that (on average) 16 % of resources are at any given time incorporated into the economy, possibly reaching 15 % to 50 % of resources, with a return time of one month per year. This rate suggests possible harm to the ecosystem, without, however, suggesting significant risk of water provisioning. But since the uses are rather underestimated, this class and the basins involved are to be further examined after data revision.

The two last classes, 46 and 17 sub-basins, totalling 63, make up a percentage in number in sub-basins of between 15 % to 18 % of the total number of computed catchments, on the unlikely assumption that the non-documented basins are all equally apportioned across the classes or unproblematic.

In these basins, the average quadratic mean of monthly WEIs ranges between 36 % and 54 %, meaning resources are under a great deal of pressure. In the scarcest group, the 10 % nWEIs (those reflecting the high water period) are also very high, suggesting a structural scarcity for at least 17 % and up to 20 % of sub-basins.

The last group probably covers two categories and is likely to also comprise sub-basins, in which the scarcity is more a recurrent than a structural issue; this is suggested by the mapping of the nWEI in the next sections where geographical distribution is discussed.

1.2.3 *Result no 3: information on scarcity and water use*

Similarly, an indicator of net consumption has been computed (called 'pseudo WEI+', because it is not produced under the WEI+ process), and shows that two ([3]) groups of sub-basins present both a high interannual average (in practice ~ 10 % and ~ 20 % of resources totally consumed), and 90 % values close to 50 %, indicating structural overuse of water. On average, 16 % to 19 % of sub-basins are likely in significant overconsumption of resources, whereas 6 % to 7 % are in sharp overuse of resources.

Risk of scarcity is clearly driven both by low resources and by irregularity in resources. This factor is recognised as highly relevant, and can be addressed effectively only if reasonably long time-series, disaggregated below the season, become available. In the current exercise, the time disaggregation is satisfactory; the duration of the computed period had to be limited to 8 years (96 months) because of insufficient data.

During the validation phase, the representatives of countries where interannual variability is exacerbated pinpointed that 8- or 10-year periods were too brief. This is accurate and relevant especially when long-term reservoirs (underground or surface) are found only once over scores or decades.

In this instance, variability has been assessed by considering the ratio of the nWEI percentiles; higher variability patterns are evident in areas showing Mediterranean and Atlantic regimes. More detailed analyses should be carried out, considering the geological background and characteristics of groundwater systems that were not taken into account because these data could not be delivered in time for the exercise.

1.2.4 *Result no 4: ancillary information and ecological flows*

The ecological flow is an important driver for meeting the EU Water Framework Directive (WFD) ([4]) objectives of restoring or keeping the best-suited ecological status. Proposing any indication would lie outside the scope of the report. However, two categories of outcomes must be mentioned. Progress is possible thanks to the development of a consistent river reference system to back the water balances and the enlargement of the assessments based on reported data, thanks to the combination of this reference system with the reported data and the water accounts side-results.

First, a global result has been computed as a test indicator that represents the share of resources that remain downstream of any catchment. This can cover any return period and has reasonable frequencies of 2 % to 10 % trespassing (a share which is larger 98 % to 90 % of the time) — roughly one month per ~ 5 years to once a year on average. This poses a significant threat to ecological resources that are more sensitive to extreme events (in restored areas) and that are more deeply impacted in their restoration by frequent adverse events than by water supply: an ecosystem that 'dies' every five years disappears, another threatened every year cannot recover, whereas a water shortage with the same return time is compensated by exceptional measures (e.g. banning private car-washing, limiting irrigation of golf courses, etc.).

Over the period computed, one tenth of sub-basins are likely to be submitted to systematic stress; whereas ~ 30 more (close to 20 % in number of sub-basins) should be explored under this issue. More accurate results can be achieved with two simple supplementary actions.

(3) The detailed analysis produces three categories, but the most consuming have been grouped together in the synthesis.
(4) Directive 2000/60/EC of the European Parliament and of the Council establishing a framework for the Community action in the field of water policy.

1. Having better data and a longer period explored, to prepare the assessment of the appropriate 'ecological flows'.

2. Deepening the analysis with a comparison at river segment level, between the hydrological conditions (by reference to the catchment's conditions) and waterbody status. This is a very simple undertaking since all data are in the same reference system (European Catchments and Rivers Network System (ECRINS)).

1.3 Data issues: lessons learnt

Environmental accounting is possibly the most effective means to quality assess data sets. This is due to the methodological obligation to process data sets independently (to avoid any circularity) on the one hand, and to rigorously confront independent data while closely mimicking the natural cycle, on the other.

Innumerable data issues were encountered; these could only be partly addressed during the water accounting process as presented here. These issues, along with the proposed solutions, constitute one of three categories of issues calling for targeted solutions, with the central one linking all three.

1.3.1 The reference systems

Appropriate reference systems have a key role. At the moment, environmental accounting methodological principles should form a central framework of data processing for all environmental assessments related to spatial distribution.

However, only ECRINS has been developed to a point where its use is feasible, as an EEA-wide reference for surface hydrological systems. Gaps and errors remain, and conceptual developments are needed concerning canals and defluences that are essential in water conveying. These changes should form part of version 1.5, and in a few years, version 2, with geometrical accuracy closer to 1:100 K rather than 1:250 K.

Despite this, the attachment of point objects (monitoring networks, dams, pumping, etc.) is not yet a routine maintenance step. Moreover, it is clear from recent ancillary productions and despite the INSPIRE Directive (Directive 2007/2/EC) ([5]) recommendations, that the central role of the reference system to attach all these categories has not yet 'copied' in the intellectual schemes of some experts.

The acknowledged relevance of ECRINS should not conceal the critical gap represented by the insufficient development of the other irreplaceable reference systems required for environmental (not only water) accounting:

- for groundwater systems, the good example of the French BD Lisa (Base de données des limites de systèmes aquifers: aquifer's systems delineation database) should foster comparable developments and integration, hopefully with the support of EuroGeoSurveys ([6]) for example, with the current developments by the European Topic Centre for Spatial information and Analysis (ETC/SIA) being an intermediate step;

- bedrock and soil systems integration;

- major artefacts on land, namely the cities and their relations as spatial objects.

The interrelationships between these objects, to outreach the geographic information system (GIS)-based correspondence and achieve correspondence between identifiers ([7]), is the way to dramatically increase the productivity of assessments, as anticipated by ETC/SIA work plans in the past years.

1.3.2 Improving the conceptual model of data organisation

Environmental accounting is not processing one data set; rather, it is processing numerous data sets in their spatial context and aiming to 'blend' them together. The experience from water accounting, applicable for all categories of environmental

([5]) Directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community (INSPIRE).

([6]) EuroGeoSurveys is an organisation of 33 European Geological Surveys. Our statutory aims are to address the European issues, to promote contribution of geosciences to EU affairs, to assist EU to obtain technical advice and to provide a network between the geological surveys http://www.eurogeosurveys.org.

([7]) Finding that A relates to B by GIS is long, resource-consuming and better done once, verified, and then processed as ID of A relates to ID of B. This is simple in principle, but calls for planning, organising and maintenance. Once done, the processing is increasingly speedier.

categories, suggests that improvement calls for envisaging a radical change in the data organisation paradigm: collecting data in their spatial systems, and not integrating the collected data later in their spatial containers.

This has many practical and organisational impacts. For instance, data are collected per data category (per topic) and are not driven by the universe in which data are relevant. Data uses are collected as one of the many 'water data', and not using a 'user-comprehensive approach': water used for human consumption is hence not collected from the 'city' perspective in the topic approach, and eventually, data collected in this way cannot be used for the accounting exercise. Considering water in the city, for example, the driver is the water cycle in the specific city, not water use in cities in general; collecting domestic water data as part of the water process does not provide information about cities, and water data are insufficient as well. As a result, none of the data sets collected from a topic perspective are complete, accurate and correctly usable.

Similarly, there is little information on industrial or energy production water uses, because this is not embedded into an industrial activity or energy production activity in which water is a component.

It may be considered self-evident that river-discharge data collection follows the appropriate process. This is not the case: in the reported exercise, 2 000 of 9 000 documented (with discharge values) gauging stations could not be used, since they could not be properly attached to river drains owing to insufficient placement information. Moreover, many discharge data were considered of poor quality due to not meeting the expected range of values for the basin they drain.

This highlights the need to embed all spatially related information (city, industry, gauging stations, sewage plants, etc.) in a hierarchical spatial context of time-event, spatial 'superstructure' (the location) and the 'infrastructure 'the global context of the point located': this hierarchy ensures the soundest way to quality assure the information. This assurance, again for performance in using resources and accuracy of reporting reasons, should be carried out in three steps. Exemplifying (simplified) with river discharge is self evident:

1. time series are validated by time irregularities (and when documented, with historical data);
2. flow values at stations are validated by reference to productivity at stations (catchment needed);
3. stations are validated in the basin context (forest, other stations, etc.) by reference to the spatial infrastructure.

These findings are detailed in Section 3.5.

1.3.3 Data storage and management

Water accounting cannot be the outcome of processing two sets of data, i.e. of time and space variability. The very fact that rivers are individually significant and the necessity to balance results of many classes demand large data sets. These data sets are not collected just for the sake of water accounting; they have to be fully consistent with other applications, and cover a very large area (the order of magnitude is in the range of 10 million kilometres squared).

As demonstrated in the report, many data sets have to be processed from the daily resolution, to provide accurate monthly aggregates. All these data need storage space: tables and databases require up to several terabytes (TB), in contrast to MS Access® desktop databases (limited to 2 GB).

This structure has been developed as a prototype for the accounts (for example, the climate monthly data are ~ 36 GB ([8]) and the source discharge is ~ 20 GB), with the management tools allowing the operators to manipulate data.

The architecture of Water Information System for Europe (WISE)/Waterbase, used within this project, is not tailored to these developments, and is understood to serve as summary data for the general public, with all time-dependent information ranging from meteorological to uses being stored in a single MS Access® database. Currently the database is undergoing enlargement and development towards a common data structure, which captures the complex needs of the efficient integration between spatial and tabular data. This will provide a system, allowing bringing the results of water accounts not only to internal use between EEA and the Commission, but also to share it with a wider audience as part of the EEA environmental assessments.

Some developments and integration are needed to render this summary database the outcome of the

([8]) For other purposes, daily data have to be stored, rendering the size for 10 years in the range of 1.4 TB.

aggregation process from the professional database — that must itself be completed for systematic running of the accounts.

1.3.4 Practical brakes on data flows

Improving the conceptual model of data organisation is irrelevant if no data are eventually collected. Data collection, with prior data identification and location, is an underestimated task, managed alongside 'orphan data', those essential data that are not part of any data collection process.

There are three major issues of data collection for environmental purposes, addressed in the next three sections.

Inaccurately identified data
In these data sets, data are supposedly present, but actually are missing or are not suited to the context. Most water usage data fall into this category (with the supplementary jeopardy of access restrictions). In most cases, inaccurately identified data are a result of incorrect reporting processes: the most prominent example is the European Pollutant Release and Transfer Register (E-PRTR), which provides information on industrial emissions. In fact, it contains no information on water volume, a key vector of liquid pollution.

Inaccurately identified data could be mitigated by two synergistic processes:

- since water uses have a very asymmetric distribution, identify the reference population and address the values and spatialisation using a stratified statistical approach;

- since information access is split between 'political actors' that may provide it (but cannot), and technical actors that can deliver data (but may not), create the conditions for political bodies to allow technical associations so that they provide or track information, under the conditions of the previous process.

As an Eionet main node, the EEA could foster such a development, fully in line with the already highlighted concepts of processing information by universe and not by topic.

Known data with restricted access
Accessibility to data in Europe and even in the EU varies. For example, for data as essential as that of river discharge (used for all environmental accounts and many assessments beyond accounts), the status ranges from fully and freely available online, to absolute restriction, in some countries even extending to restricting knowledge of where data are stored.

Another significant restriction in data access stems from privatisation of many former public services. For example, reservoir changes in volumes were publicly accessible before privatisation in meeting EU directive targets: these data are now considered 'industrial secrets' and must be reconstructed.

There are three ways, to be explored in parallel, to make essential data available for environmental accounting, and more widely for environmental assessment and support of EU objectives of sustainable development in the context of climate change and the best use of natural resources.

1. Continue the processes started for the accounts; and organise (within SEIS and Copernicus [9]) and maintain the inclusion of essential data from those countries open to provision, while trying to convince others.

2. Use a stepwise process, under the aegis of international organisations (e.g. the World Meteorological Organization (WMO)) towards centralised data collection. An initiative to use the Global Run-off Data Centre (GRDC) for river discharge data is under way. However, as demonstrated in this report, this pathway cannot substitute direct data collection if no substantial revision of the data collection scheme is first set up by these organisations.

3. Jointly with the Commission, elaborate upgrades of the EU legislation, so that some data become part of compulsory exchanges; however, this method will not cover the EEA, whose mandate extends beyond the EU.

Orphan data
The category of orphan data clusters those data that exist and are accessible (even if lacking sufficient density) but whose use for the process requires deep and consistent specific processing.

(9) Copernicus (not Kopernicus) is the new denomination of GMES, from December 2012 onwards.

The most significant is meteorological data: rainfall, actual evapotranspiration, temperature, etc. are data essential for all environmental processes (water accounts, carbon accounts, ecosystem services, etc.). Despite this, there is no defined process to draw up these data.

The case of meteorological data serves as a good example: the development of water accounts is founded successively on three different sources.

1. Advanced Terrestrial Ecosystem Analysis and Modelling (ATEAM) data: fine spatial density but insufficient time density; discontinued in 2000, and hence no longer suited.

2. Monitoring Agricultural Resources (MARS) (JRC-sourced) data: fine time density but insufficient spatial density, with restricted accessibility; odd quality for the accounts (oriented to agriculture in plains); no longer used by the EEA from 2010.

3. The ENSEMBLES E-OBS ([10]) data set, obtained via the European Climate Assessment and Data (ECA&D) database: fine time density and acceptable spatial density (with some noticeable exceptions, which could be improved); odd quality (depending on the Ensembles data set); in-house modelling not planned for the next years and no alternate solution envisaged. Time series are updated regularly every six months.

Without stable and consistent meteorological data sources, the accounting cannot be continued.

River discharge data is to some extent orphan data as well, since its current organisation, as supported by the collection in Eionet Member Countries left open issues in terms of meta data description regarding spatial integration and possible time series which gives a certain limitation to the use in the Accounts calculations.

1.3.5 Orientations

New sources become available, especially from space and global climate reanalysis. Two promising new sources of information must be mentioned: although they have not been used yet (NVDI has been checked in another context), they should probably become validation sources for the water balances, and be further integrated with carbon and ecosystem accounting:

- NVDI, resulting from red/infrared processing, has been analysed for forest assessment; it seems very promising following its processing and integration into a database server for validating soil humidity ([11]);

- The Gravity Recovery and Climate Experiment (GRACE) (GRACE, 2013) project on microgravity changes seems a reasonable framework for assessing groundwater reserve changes as well as ice caps changes — both stocks that call for more data and that should be tested (after the aquifers have been inserted as reference systems, of course).

- The Soil Moisture and Ocean Salinity (SMOS) (ESA, 2013) project. As its name suggests, the SMOS satellite was designed to measure how much moisture is held in soil and how much salt is held in the surface waters of the oceans. Data series have been available since early 2010 and may potentially be used in future.

1.4 Organisation of the report

This report aims at being as comprehensive as possible: it describes the outcomes of the full-scale realisation of water assets accounting across Europe. Water accounting is a combination of methodology and exploitation of heterogeneous data sets, and it seemed important to cover all issues related to methodological adjustments, data processing, data flows, organisation, and results, as these may contribute to policy support.

To achieve these different goals, non-essential technical insights were excluded from the main text. These insights are instead reported in the appendix section that covers methodology, reference systems, and data issues. The relevant appendices are indicated in the main text and can be read independently if required.

([10]) The ENSEMBLES project (contract number GOCE-CT-2003-505539) is supported by the European Commission's 6th Framework Programme as a 5 year Integrated Project from 2004–2009 under the Thematic Sub-Priority 'Global Change and Ecosystems'. http://www.ensembles-eu.org.

([11]) NVDI / NDVI, the Normalized Difference Vegetation Index (NDVI) is a simple graphical indicator that can be used to analyse remote sensing measurements and assess the photosynthetic activity. A report has been prepared by consultant (SCM: Société de Calcul Mathématique), under framework contract with the EEA.

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