Abstract # 1832

Global Distributed Groundwater Contribution to Environmental Flows and Sustainable Groundwater Abstraction Limits for Sustainable Development Goals

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Figure1. The 17 SDGs

Seventeen Sustainable Development Goals (SDGs) were adopted for the post-2015 development agenda at the UN General Assembly in, 2015. Out of these, Goal 6, i.e. "Ensure availability and sustainable management of water and sanitation for all" is focused on water. To address sustainability and ecosystem maintenance, environmental flows (EFs) – water that needs to be specifically allocated to environment - should be an integral component of the SDG discourse. Yet, there is a lack of awareness of EFs at multiple levels and lack of consistent and easy to use, readily available EF data to feed into the SDG process. Many countries have still not applied EF concepts or practices. If countries are to accept and implement EF targets over the next 15 years in the context of achieving the SDG targets, some baseline EF information needs to be provided.

The present work assesses distributed (0.1 degrees resolution) annual EFs for surface runoff-contributed as well as groundwater-contributed components of streamflow. The groundwater-contributed EFs support the assessment of sustainable groundwater abstraction from renewable sources. The desired flow and environmental conditions of rivers are defined by four environmental flow management classes (EMCs). The percentage of flow required relative to pristine natural conditions, and the volume of groundwater and surface water that may be withdrawn without impacting the EFs are calculated for each EMC globally.

2 Methodology

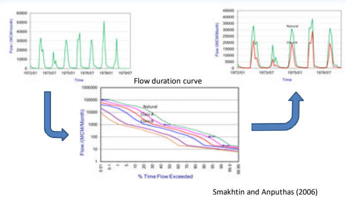

Figure 2. Hydrograph analysis

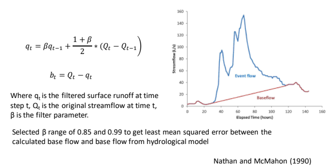

Figure 3. Baseflow separation

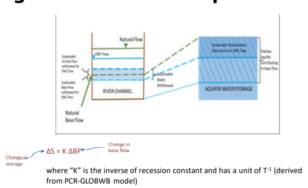

Figure 4. Sustainable groundwater assessment

Step 1: Simulated natural river flow time series (1960 to 2010) from PCR-GLOBWB, developed by Utrecht University, were applied at the grid scale to determine flow duration curves (FDCs) for four EMCs by shifting the original FDC to progressively lower flows retaining flow patterns. These were then converted back to time series for each EMC.

Step 2: Baseflow, representing groundwater discharge, was determined through baseflow separation under natural and EMC flow conditions. The baseflow filter parameter β was calibrated against model data to constrain baseflow separation.

Step 3: Excess baseflow above environmental baseflow representing the different EMCs was estimated. This was then converted into catchment storage of groundwater that can be sustainably abstracted, assuming shallow aquifers to be linear reservoirs. The method avoids double-accounting of abstraction from groundwater and surface water.

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3 Results

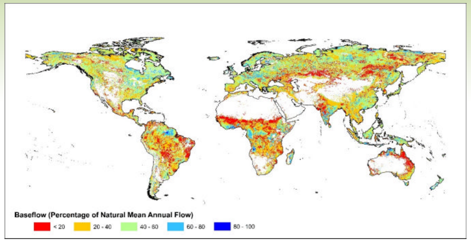

Figure 5. Baseflow as percentage of natural mean flow

Table 1. Sustainable groundwater abstraction, aggregated at regional scale

Region	Sustainable groundwater abstraction (km³/a)			
	EMC "A"	EMC "B"	EMC "C"	EMC "D"
Asia	77.9	133.0	170.0	194.0
North America	24.0	41.6	54.0	62.4
Europe	12.0	20.9	27.3	31.7
Africa	11.0	18.9	24.2	27.6
South America	17.1	29.4	37.8	43.1
Oceania	5.2	8.9	11.4	13.2
Australia	1.7	2.9	3.7	4.15
Global	148.9	255.5	328.4	376.2

Baseflow is highly variable across the globe.

The calculations in Table 1 assumes that the contribution to the EFs is being met by surface water and groundwater in the same proportion as in case of natural flow. For EMC "A", roughly 150 $km^3\ a^{-1}$ of groundwater can be abstracted sustainably.

For EMCs "B", "C", "D", roughly 255, 330, and 380 $km^3\ a^{-1}$ can be abstracted sustainably, respectively. From modelling of present-day global hydrological scenarios, the total and non-renewable groundwater abstraction in 2000 are estimated to 734 and 234 $km^3\ a^{-1}$, respectively (Wada et al. 2012). This illustrates that present day exploitation of groundwater is already reaching limits in certain areas of intensive use, e.g. north-western India, the north-eastern parts of China, and the mid-west and western US.

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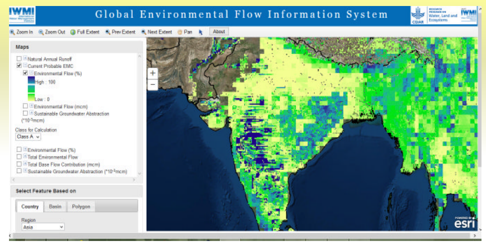

Figure 6. Online global EF and sustainable groundwater abstraction calculator

An online tool for determining EFs for surface water and sustainable groundwater abstraction for selected catchments or areas of interest was developed.

5 Conclusions

- Globally distributed EFs at 0.1 degree resolution has been estimated
- EFs are dependent on Environmental Flow Management Class (EMC)
- Sustainable groundwater abstraction limits (0.1 degree) based on EFs have been estimated
- Online tool to obtain EFs and sustainable groundwater abstraction information in any area of interest has been developed

6 References

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