Water accounts in the Netherlands

Cor Graveland, colleagues
Outline

- Water issues / problems in NL
- Dutch water accounts
- History / Projects / international
- Physical Water flow Accounts
  - Sources
  - Methodologies
  - Experience / challenges / difficulties / ...
- Results & indicators
- Use / policy use of PWFA in NL
Water issues in the Netherlands

- Safety, protection against flooding
- Water management: excess of water
- Water management: water resources and water use
- Water pollution
- Water quality
1. Physical water flow accounts (m³), water flows
2. Physical asset / stock accounts for water (m³)
3. Water mission accounts, based on emission registration (kg), national and regional data
4. Water quality accounts
5. Economic accounts for river basins, mainly based on the national and regional accounts (euro’s, employment)
6. NAMWA matrix (NA Matrix including water accounts), incl. water related monetary data (taxes, subsidies etc.)

7. Economic Performance of EGGS particular in water
8. Economic description of the North Sea (NAMWA)
9. Economic performance of flood prone area
10. Valuation of Dutch water resources (ecosystem accounts)
11. Indicators for water
Physical water account

– Supply and use of water (products) in the Dutch economy in m³
– Use: tap water, groundwater, surface water (‘industry water’)
– Abstraction from environment: surface water, groundwater, soil water, eventual rain harvest
– Resident principle
– Distributed over 38 industries and households
– Data sources: water statistics, environmental reports (PRT-Register), data from water companies and detailed information from LEI
– Connect to monetary water data in NA
– Time series 2003-2012 (historic figures 1990-2001)
Policy demands

- **Main users**: Ministry of infrastructure and environment, water boards, water companies, Eurostat, other etc.

- **Water Framework Directive**
  - Description of the economic importance / interests related to the use of water
  - Important as potential ground for derogation (disproportionate costs; socio-economic reasons)

- **Marine Strategy Framework Directive**
  - Initial Assessment asks for ‘Economic analysis of marine waters’

- **Climate change policies** → expenditure for climate change mitigation / adaptation

- **Indicators for green growth, for SDG’s, use-efficiency, to determine water stress, ..**
Ongoing dvmt of Water Accounts in NL(1)

1. **1996**: Pilot: first experimental NAMWA
2. **2002, 2003-2005**: Extensions of original NAMWA further extension: addition of more pollutants, more detail for river basins
3. **2006**: ES - Pilot project ‘Dutch Water flow Accounts
4. **2007-2008**: IO-analyses, decomposition analyses
5. **2009-2010**: Water abstraction and –use at 7 River Basins (Baas & Graveland)
7. **2011**: Aim to compile full Water balance / water asset accounts for national territory
8. **2010-2011**: TF on RUMEA incl. water. Aim to test CRUMA on Resource Management Activities (& R.Use)
Ongoing dvmt of PWFA in NL (2)

6. **2011 – 2013(..) CREEA-project:** Compile & refine econ & environmental accounts incl. water → PSUT
7. **2011:** Contribute to OECD green growth indicators incl. water
8. **2012:** Pilot water quality accounts
9. **2013:** Time series 1976 onwards for tap water & surface & groundwater
10. **2014:** Experimental valuation of Dutch water resources following SNA & SEEA
11. **2015:** Min. of economic affairs add to material monitoring also physical water via detailed (133 industry) PSUT

12. **Future plans:**
   - Composite indicators
   - Environmental - Economic Analyses
   - Water footprint / virtual water work
   - What in regular production?
On water abstraction, water use, water assets:
1. Join the work between water statistics & water accounts in the NSI and elsewhere
2. Use register data
3. Connect / cooperate with external organizations
4. Surveys / questionnaires only if really required
5. Eurostat grants highly appreciated or essential because allows for on-going development
6. Eurostat connection via WG & TF essential to facilitate data & methodological development (i.e. DSDs)
1. **Agriculture** (ISIC 01-03), from FADN, LEI (Agric. Research inst.)
   a. Sample survey plus extrapolation per farm type
2. **Industrial Activities** (ISIC 10-35, 37-39) from AERs via the PRTR
   a. Annual Environmental Reports (AER) of 1000 companies
   b. Additional estimates by NSI for some NACE 3-d
   c. Extrapolations (former) former Nat. water Survey
3. **Public Water Supply** (ISIC 36) from VEWIN (Assoc. of Public Water Supply companies)
   a. Statistics of 10 Public Water Supply Companies (PWS)
   b. Includes supply to households
4. **Services, etc.** (ISIC 40-98), customer files from 10 PWS (Drinking Water)
   a. Water use coefficients (m3/year) derived per employee per ISIC 3 digit
   b. Combined with labor accounts (remainder)
   c. Extrapolated to new years
5. All ISIC, from Nat. groundwater register (Provinces, Water Boards) (2014 pilot)
6. Optional monetary figures: National Accounts (check)
7. Optional: Data Tax authorities
8. Balancing
Methodologies

- Main sources for water use data: external registers and the water statistics
- Enlarge observed selections of data by means of additional estimates, extrapolations to totals, etc. (NSI)
- Confront bottom up data with top down totals (PWS) which introduce balancing item for drinking water use
- Compile regional (River Basin) data by:
  - Use of the spatial information in the source data, i.e. in the SBR or i.e. n farm locations
  - Apply regional statistics (inhabitants, employees, etc.)
- Trend in towards getting the micro – based data
  - Use of the National Groundwater Register
  - Use of ‘industry water’ in Industry (ISIC 10-39)
  - Potential for connecting with other data (big data)
Methods for regionalization water data

Methods:
- Water use of households: distributed via data of 10 Public Water Supply companies combined with number of inhabitants per municipality per river basin
- Agriculture: on request distributed over the river basins by LEI
- AER data for industry: individual users / abstracters/are located via x-y coordinates
- Additional estimates for manufacturing industry are allocated to river basins by use of employee numbers per river basin
- Public Water Supply companies: river basin data (abstractions) can be compiled on basis of VEWIN data
- Water use by services: distributed to river basins along employee numbers per river basin.
Results: Water Use households

- Tap water use by households
- Tap water use by Industries
- Compilation in detail 2003-2012
- Time series from 1970 onwards by completion of old data via statistical methods
- Statline publication of the data (in English)
- Combine with population data
- Per capita water use
Results: Tap water & production

- Tap water used for production activity & Volume change GDP, employment combined
- Compilation in detail 2003 -2012
- Time series from 1970 onwards via statistical methods
- Statline publication of the data (in English)
Results: What are the most important water users? Is their water efficiency improving?

2.3.4 Industries with the highest tap water (drinking water) use intensities

[Bar chart showing water use intensities across different industries for 2012 and 2003]
Experience / challenges / difficulties / …

- General, the ‘organisation’ of the data requires sufficient amount of time
- Dependent on FADN (LEI), if monitoring stops or enlarging exercise gets to costly, we have a problem
- Outside the observed population via the AERs in manufacturing accuracy and quality of the figures is limited and hard to judge
- What industry detail is preferred, needed, doable?
- Connection of micro level data (i.e. for) water to the Business register (SBR) deserves more attention to use full potential
- Balancing is very important and requires more guidance and examples
- The use of customer files from PWS has potential, but is very labour-intensive, costly, but has mutual benefit. Can only be done in a joined project
- Biennial production of the data saves time and budget
- Support and coordination by Eurostat is crucial
Example Asset Accounts (1)

- Objectives:
  - Water balance:
    - Precipitation, evapotranspiration (inland)
    - & External inflow from upstream, Other flows and actual outflows
    - Exchange of water between river basins ...
  - Abstractions & discharges at 7 (sub-) River Basins ...
  - Stocks ...
    - Groundw., Surface W. & Soil Water
  - Tuning
Actual Evapotranspiration

– Evaporation (soil)
– Transpiration (crop)
– Per Grid
– Summer 2009
– Based upon satellite images
Precipitation and Actual Evapotranspiration (volumes)

- Results per (sub-)River Basin
- mm per year
- The volumes are calculated using the surface of land and of freshwater basins per River Basin area.
Actual external inflow and outflow of surface water

Method / processing:
– inventory and collection of flow data from water boards and national water authority
– Most files received contain daily average flow rates (m3/sec), some contain monthly flow totals.
– Inflow: 30 gauging stations at border locations
– Outflow: only to sea, in total 28 data files on 81 outlets
– Data were aggregated to monthly, seasonal and yearly totals (mio m3), national & per River Basin.
– River Scheldt (from Belgium) is not accounted for as inflow already has become marine/brackish.
Actual external inflow and outflow of surface water, overview Mln m³ / year
Quantification of major balance items

Estimates for:

<table>
<thead>
<tr>
<th>Description</th>
<th>Year</th>
<th>Summer</th>
<th>Winter</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Precipitation</td>
<td>28,294</td>
<td>12,193</td>
<td>16,101</td>
</tr>
<tr>
<td>2. Actual evapotranspiration</td>
<td>17,022</td>
<td>14,240</td>
<td>2,782</td>
</tr>
<tr>
<td>3. Internal Flow = 1 - 2</td>
<td>11,273</td>
<td>-2,047</td>
<td>13,319</td>
</tr>
<tr>
<td>4. Actual external inflow from foreign territory</td>
<td>67,962</td>
<td>31,231</td>
<td>36,731</td>
</tr>
<tr>
<td>5. Total actual outflow to sea</td>
<td>75,839</td>
<td>32,311</td>
<td>43,530</td>
</tr>
<tr>
<td>6. Total freshwater resources = 3 + 4</td>
<td>79,235</td>
<td>29,184</td>
<td>50,050</td>
</tr>
<tr>
<td>7. Recharge into the Aquifer = 6 - 5</td>
<td>3,396</td>
<td>-3,127</td>
<td>6,521</td>
</tr>
<tr>
<td>8. Groundwater available for annual abstraction = 7 (max)</td>
<td>3,396</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Abstraction of groundwater: 1,011
Abstraction of fresh surface water: 10,654
Discharges to fresh water: 11,478
Discharges to sea: 1175
Balance abstraction - discharges: 13

Imports of tapwater and water in products: 54
Exports of tapwater and water in products: 33
Assessment of Stocks of fresh water

– Stock of fresh groundwater
– Stock of fresh soil water
– Stock of fresh surface water

→ Fresh water: salinity <300 mg Cl-/l
Stock of fresh groundwater / soil water:

Source: KNAW: Geology of the Netherlands
Groundwater in the NL (KNAW), by De Vries
Stock of fresh groundwater

– Calculation (layer solely saturated with fresh water):
  - Soil volume
    • Area of land
    • Thickness of relevant soil layer (‘maximum’, ‘relevant’)
    • Upper bound of saturated zone (=groundwater table)
    • Lower bound of groundwater column, incl. fresh / brackish interface
  - The porosity (= water content) of the total soil volume vs the relevant fresh water column
– Method / approach: clear
– Parameterization: reasonable
– For 37 bln m², an estimated stocks of 800 – 1100 Bln m³
– Stock of fresh groundwater = 1000 times annual abstraction !
– National balance ((? Regionalization to the RBs?)
– Due to large bandwidth, annual monitoring hardly make sense
– Thus no yet yearly opening & closing stocks ..
– Connect to (ground) water modelers for methodology, tuning and conformation
Thank you!

Questions / remarks / suggestions?

c.graveland@cbs.nl
Stock of fresh groundwater (2)

- Printhulp
Stock of fresh Soil water

– Calculation stock of fresh soil water:
  - Soil volume
    • Area of land, with unsaturated zone above ground water table
    • Thickness of relevant soil layer:
    • Top side of unsaturated zone of soil water column
    • Lower bound of soil water column, the interface with groundwater table largely determined by ‘level of control (drainage)’
    • The porosity of the relevant soil zone (water and air)
    • Level of (un-)saturation of the pores (=water content)
  – Method / approach: clear
  – Parameterization: reasonable
  – Precision: bandwidth
  – For 37 bln m², a first preliminary estimate is around 30 – 50 Bln m³ (3 – 5 percent of fresh groundwater stock)
  – National balance.
  – Regionalization to the 7 (sub-) River Basins → requires soil type
  – Significant seasonal variation, annual monitoring requires real time monitor
  – In touch with (ground) water modellers for methodology, tuning and conformation
Stock of fresh Soil water (2)

– Printhulp
**Stock of fresh Surface water**

- Calculation stock of fresh surface water bodies (m³):
  - Area of the water (bodies) within the country (by category of water body?) in m² (1)
  - Average depth of these fresh water bodies (m) (2)
  - Method / approach: clear
- Parameterization: area good; depths within certain range
- Area of water: 7,2 bln m²
- Average depth differ
- Result in estimate of 10 Bln m³
- → Only 1 percent to groundwater stock!
- Stock = compares to abstraction of fresh surface w (10.6 bln m³)
- Inflow is even > 6 times as big (68 bln m³)
- Regionalization to the 7 (sub-) River Basins (RBs)
- Due to large variation, annual monitoring hardly feasible
- Connected to modelers and WFD people for methodology and data
Assets of fresh water

<table>
<thead>
<tr>
<th>Groundwater</th>
<th>Soil water</th>
<th>Surface water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Billion m3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1,115.0</td>
<td>'11.0 - 44.0</td>
<td>11.3</td>
</tr>
</tbody>
</table>

Conclusion:
→ Groundwater stock = 1000 times annual abstraction
→ Once for every few years, no annual opening / closing stocks
→ Inflow of fresh surface is even 6 times as big as fresh water stock
Findings asset accounts (water balance)

- Development project relied on funding by Eurostat
- Largely rely upon existing data sources (registers)
- Close cooperation water statistics and accounts
- A clear need for data by policy (law) & society
- National & European legislation is key
- Cooperation with external partners and experts has proven very useful for the project
Recommendations

- Try to base upon existing data sources (registers)
- Integrate & connect with hydrological and hydro geological models i.e. for ground- & surface water flows and soil water
- Due to bandwidth discovered, reasonable to present a range for the calculated stocks
- For quantifications of actual evapotranspiration easily better, more realistic values obtained from Remote Sensing technologies
Water abstraction

- Groundwater abstraction for production activities by industry
- Compilation in detail 2003-2012
- Added time series from 1976 onwards by adding to incomplete old data via statistical methods
- Monitoring over time
Thank you !

Questions / remarks / suggestions?

c.graveland@cbs.nl
Dutch water accounts – (printhulp)

1. **Physical water flow accounts** (m$^3$), water flows
2. **Physical asset / stock accounts** for water (m$^3$)
3. **water mission accounts**, based on emission registration (kg), national and regional data
4. **Water quality accounts**
5. **Economic accounts for river basins**, mainly based on the national and regional accounts (euro’s, employment)
6. **NAMWA matrix** (NA Matrix including water accounts), incl. water related monetary data (taxes, subsidies etc.)
7. **Economic Performance of EGGS** particular in water
8. **Economic description** of the North Sea (NAMWA)
9. **Economic performance of flood prone area**
10. **Valuation** of Dutch water resources (ecosystem accounts)
11. **Indicators** for water