# Analysis of Gaps and Trends

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KINDRA

Knowledge Inventory for hydrogeology research

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# Outline

- **Scope and objectives of gaps and trends analysis**

- **Methodology**: HRC-SYS intersections, VOSviewer approach and Scopus / SciVal (Scopus analytical tool)

- **Examples of results from EIGR and Scopus analyses**
  - □ EIGR and Scopus resources distribution
  - □ Gaps analysis
    - □ Assessment of resources at Research Topics and Operational Actions intersections for Societal Challenges in EIGR and Scopus
    - □ VOSviewer visualisations: network and density maps
    - □ Scopus and SciVal
  - □ Trends analysis
    - □ Temporal changes in Research Topics and Operational Actions intersections
    - □ Temporal changes in network and density representations visualized by VOSviewer
    - □ Temporal changes in geographical distributions of network and density representations visualized by VOSviewer
    - □ Trends analyzed by SciVal

- **Observations and conclusions**

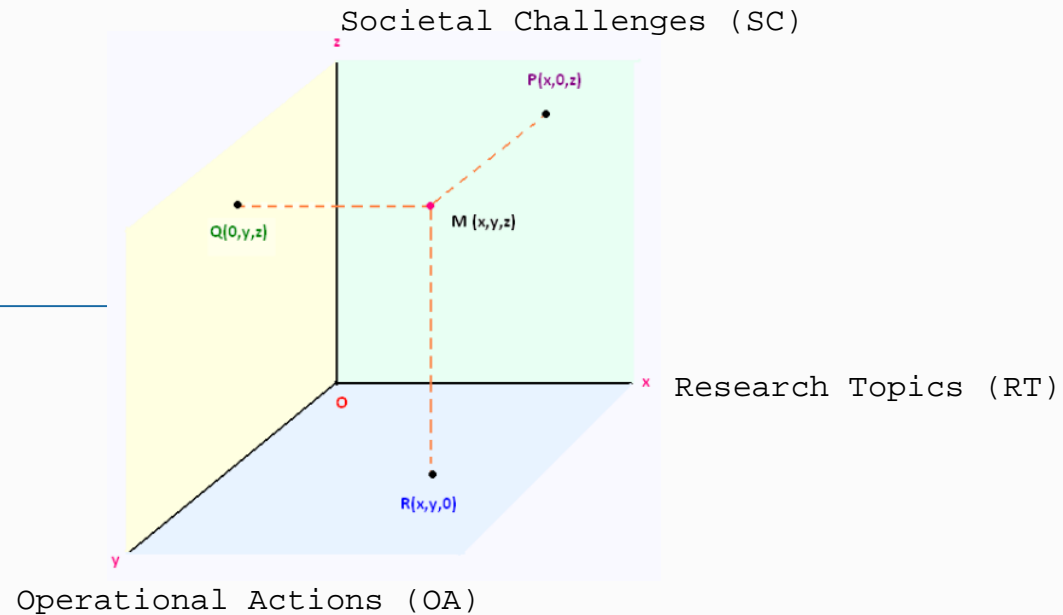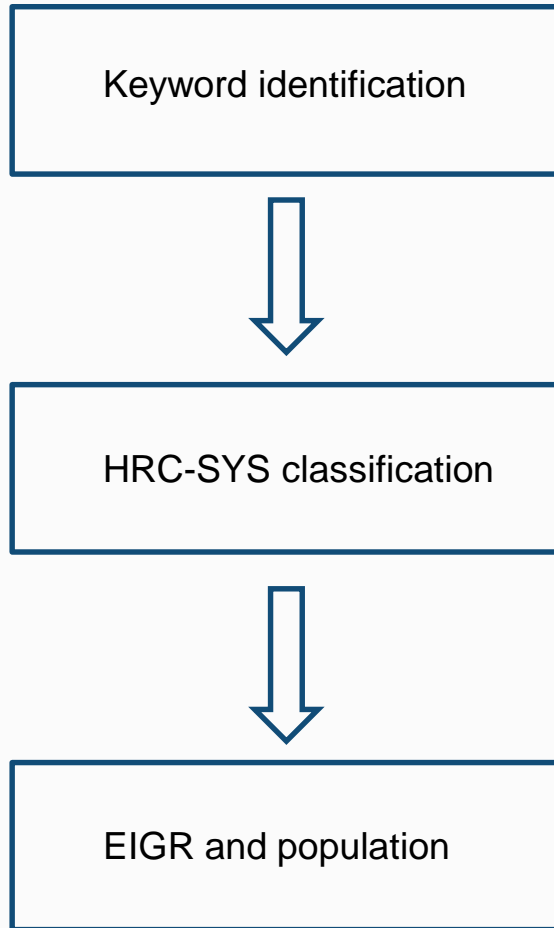# Scope and objectives of gaps and trends analysis

**Gap analysis**
To disclose knowledge gaps and research needs e.g. relevant for  the implementation of the Water Framework and Groundwater directive (WFD and GWD)

**Trend analysis**
To disclose how knowledge and research have evolved over

time (especially before and after adoption of the GWD in 2006)

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# Methodology (1/2)

```
┌─────────────────────────────┐
│                             │
│   Keyword identification    │
│                             │
└─────────────────────────────┘
              │
              ▼
┌─────────────────────────────┐
│                             │
│   HRC-SYS classification    │
│                             │
└─────────────────────────────┘
              │
              ▼
┌─────────────────────────────┐
│                             │
│   EIGR and population       │
│                             │
└─────────────────────────────┘
```

Societal Challenges (SC)

$P(x,0,z)$

$Q(0,y,z)$

$M(x,y,z)$

Research Topics (RT)
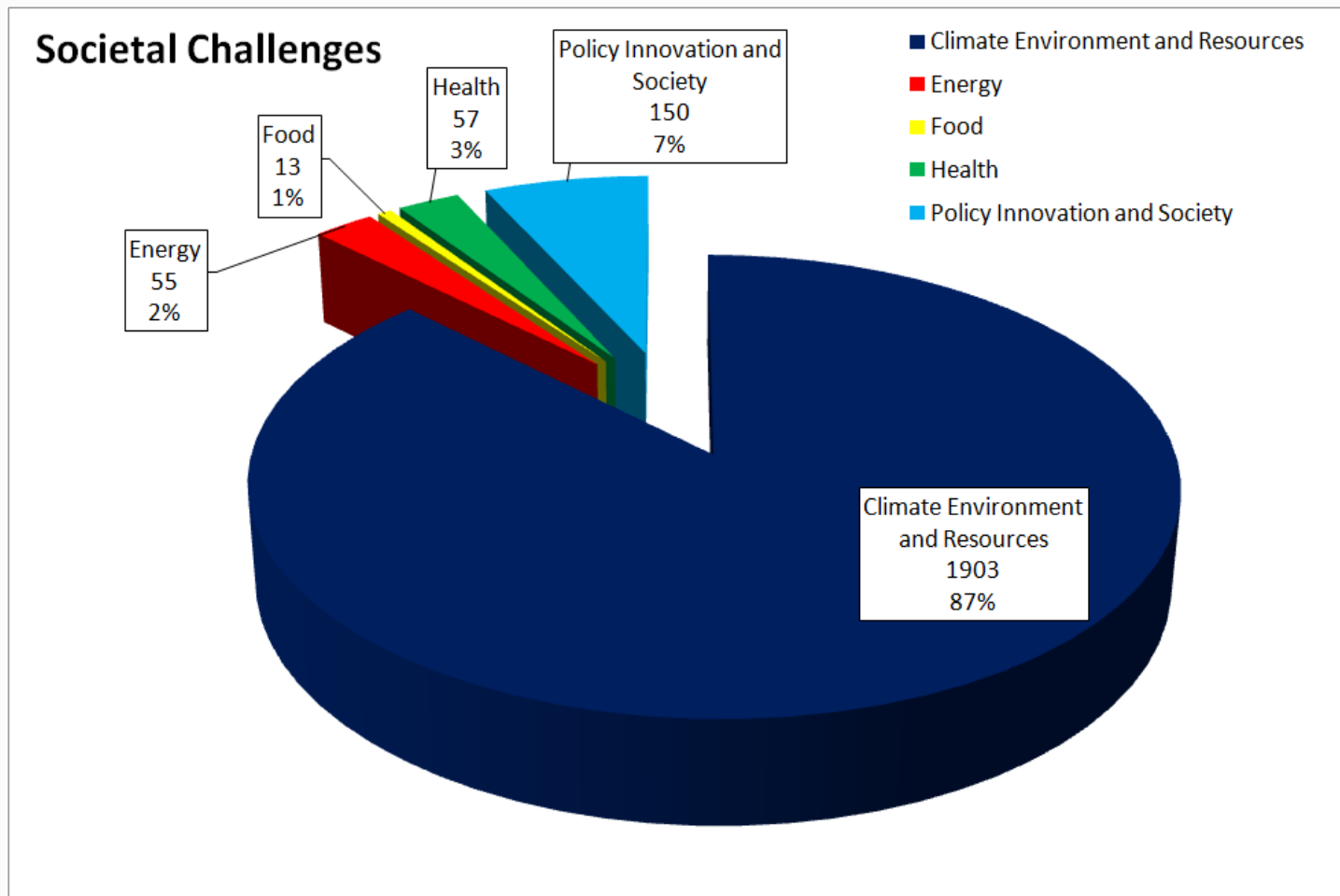
$O$

$R(x,y,0)$

Operational Actions (OA)

**Gaps:**
Populate the EIGR with (RT,OA,SC) data and
Assess the magnitude of combinations of RT and OA
For each SC

**Trends:**
Assess the temporal trend of combinations for SC

# Methodology (2/2): VosViewer analyses

All keywords



KINDRA EIGR



VOSviewer

Visualizing scientific landscapes

Nees Jan van Eck and Ludo Waltman
Centre for Science and Technology Studies
Leiden University



EIGR



abstract and citation database
of peer-reviewed literature

All keywords



Scopus

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# Results: EIGR Resources distribution (QA'ed # = 2178)

# Groundwater publications in Scopus and WoS: 1997 – 2016, (e.g. searched by keywords in KINDRA/EIGR thesaurus).



**Scopus vs WoS, 1997-2016**
Baseline search string (BSS) = Groundwater or "Ground Water" or Hydrogeolog*

■ Scopus  ■ WoS

**number of publications (Class 1 and 2)**

Search string

| Search string | Scopus | WoS |
|---|---|---|
| BASELINE SEARCH STRING (BSS) | 125003 | 94588 |
| BSS + ANY TERM FROM THESAURUS: | 124360 | 93781 |
| BSS + ANY OA TERM + ANY RT TERM + ANY SC TERM: | 63248 | 37960 |
| BSS AND NOT ANY TERM FROM THESAURUS | 643 | 807 |

**Scopus resources used for classification in Rubiks cube and comparison with EIGR resources**

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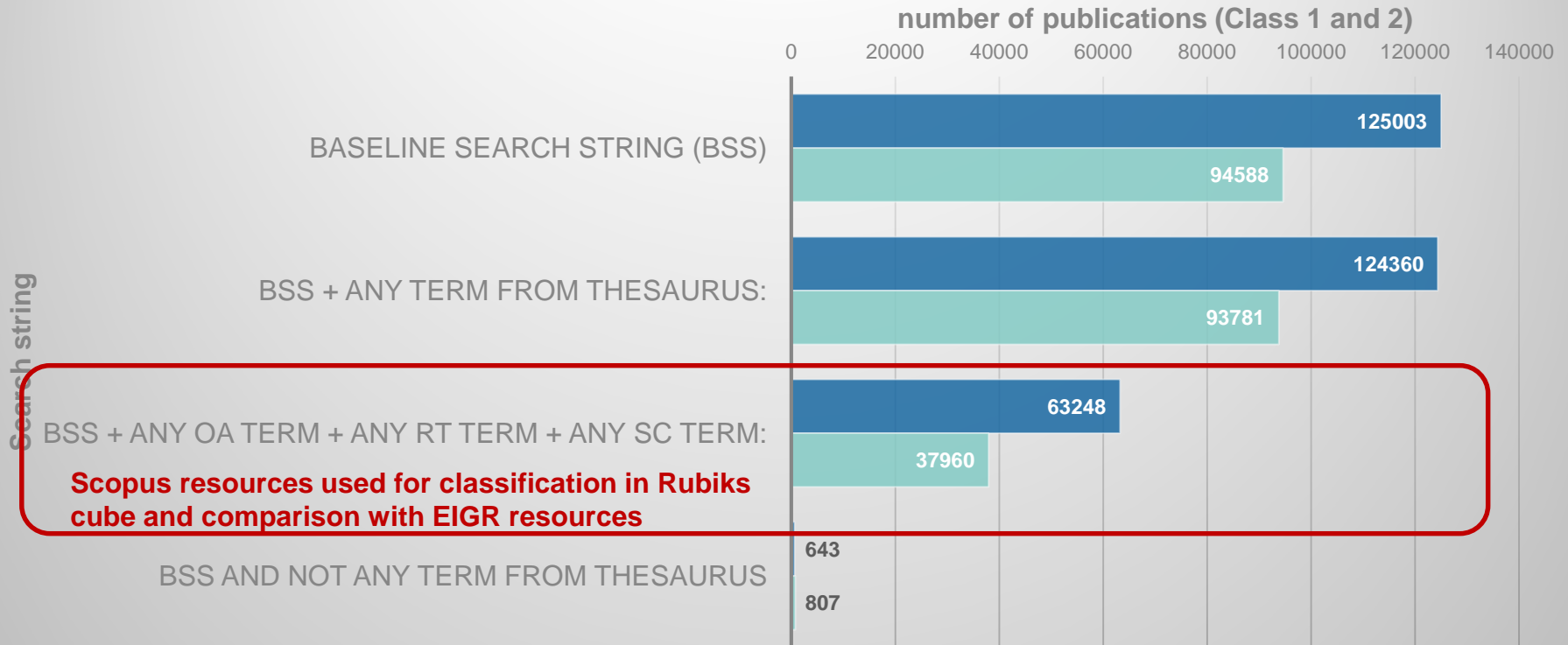
# Results: Gap analysis – example: Climate, environment and resources (SC4)

**Scopus class 1 and 2 resources (63.248 records)**

**EIGR class 3 and 4 resources (2178 records)**
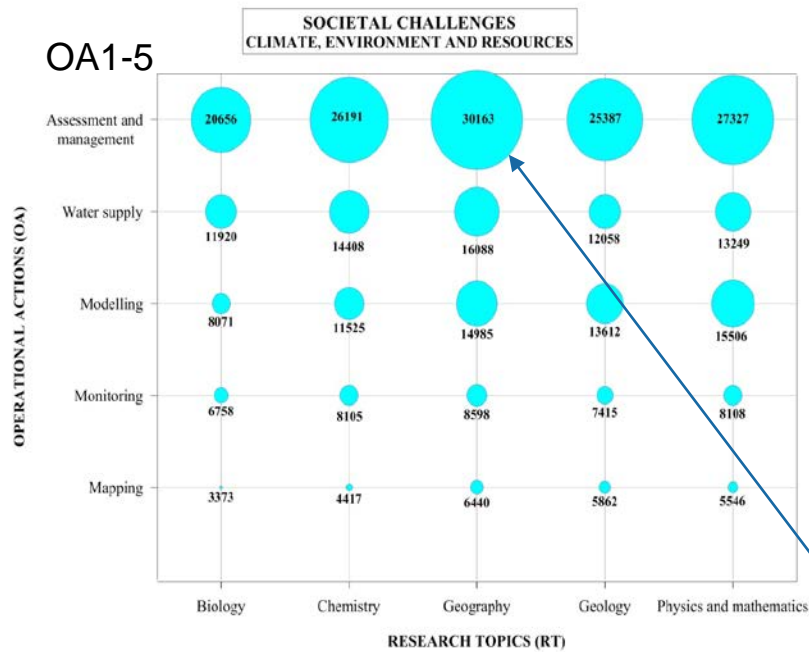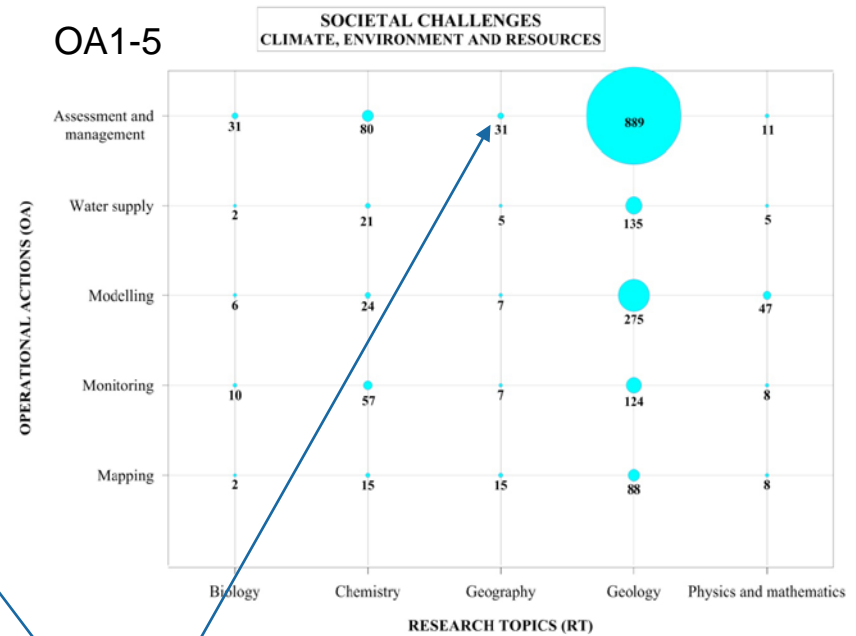


Gap in data in EIGR – missing data for the other natural science disciplines i.e. biology, chemistry, geography and physics & mathematics

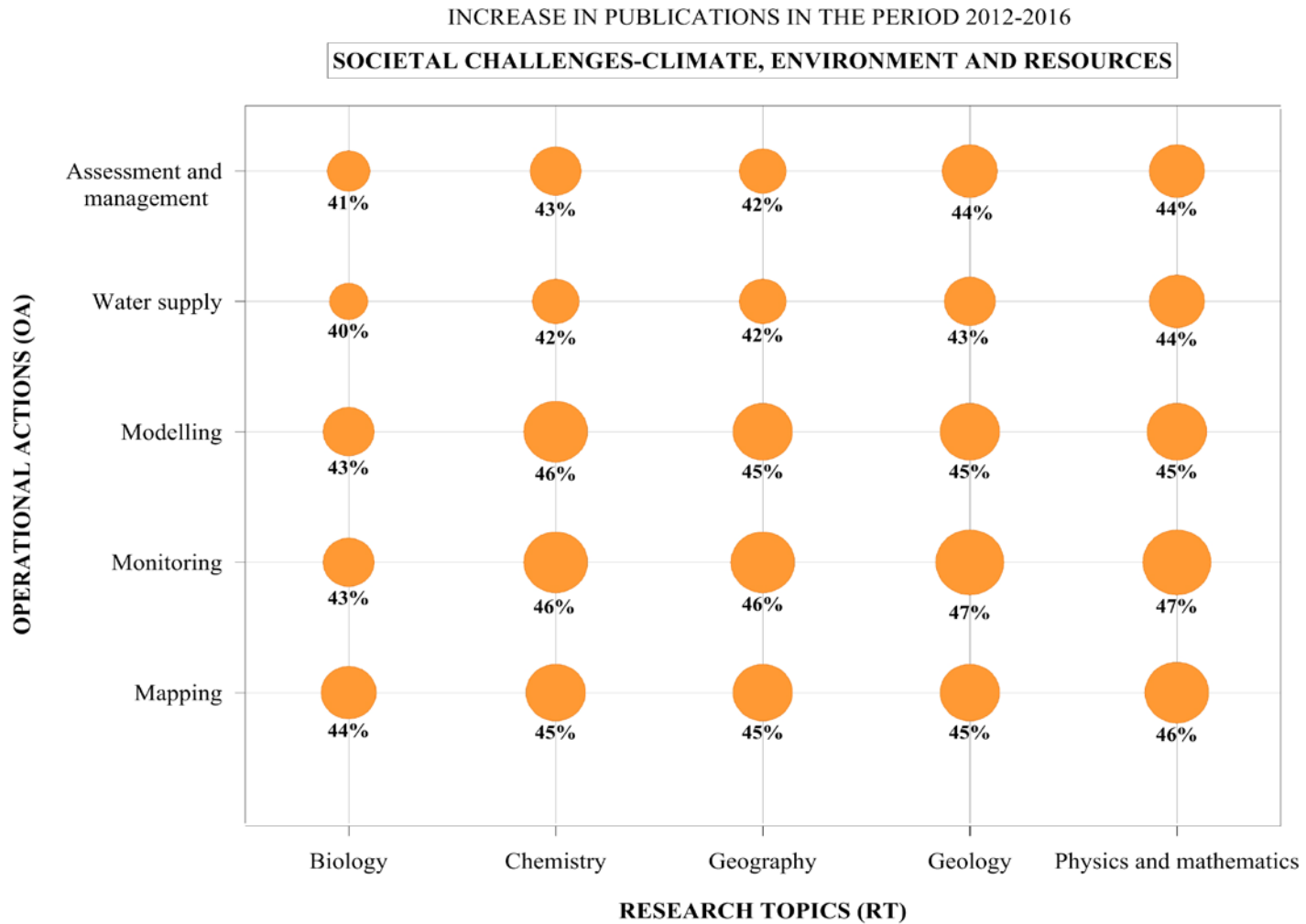# Results: Gap analysis by VosViewer density plot on EIGR data



EIGR density graph for 2178 records, 242 keywords and period 1997-2016

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# Results: Gap analysis by VosViewer density plot on Scopus data
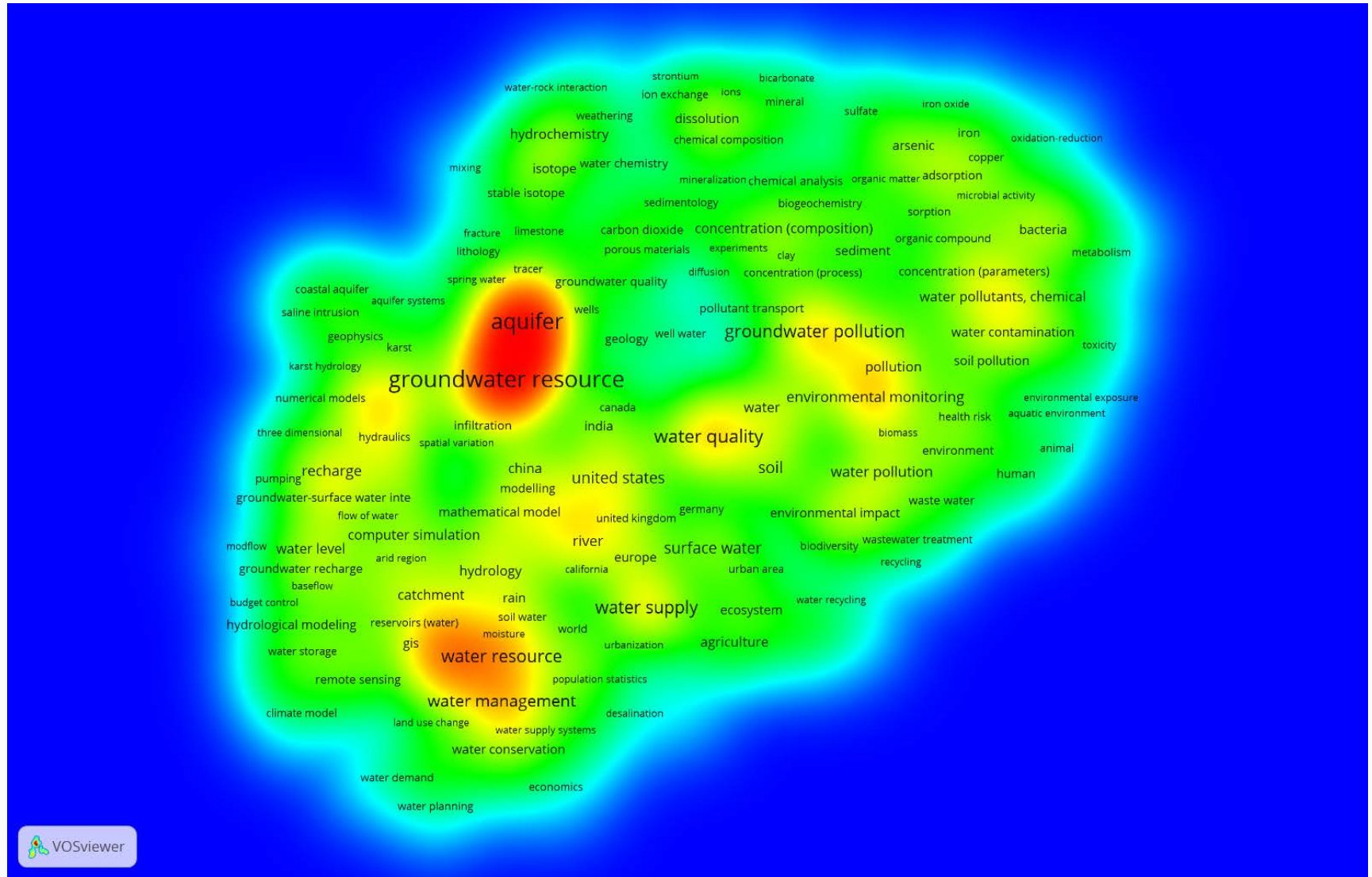


Scopus density graph for SC4-ClimEnvRes, 500 keywords and period 1997-2016

# Results: Gap analysis and VosViewer network map, EIGR data.



EIGR network graph for 2178 records, 242 keywords and period 1997-2016

# Trends analysis

# Results: Trend analysis on Scopus data



INCREASE IN PUBLICATIONS IN THE PERIOD 2012-2016

SOCIETAL CHALLENGES-CLIMATE, ENVIRONMENT AND RESOURCES

Scopus: 41-47 % of increase in resources in period 1997-2016 is in 2012-2016

# Results: Trend analysis by VosViewer density plots for different periods, EIGR data

1997-2006
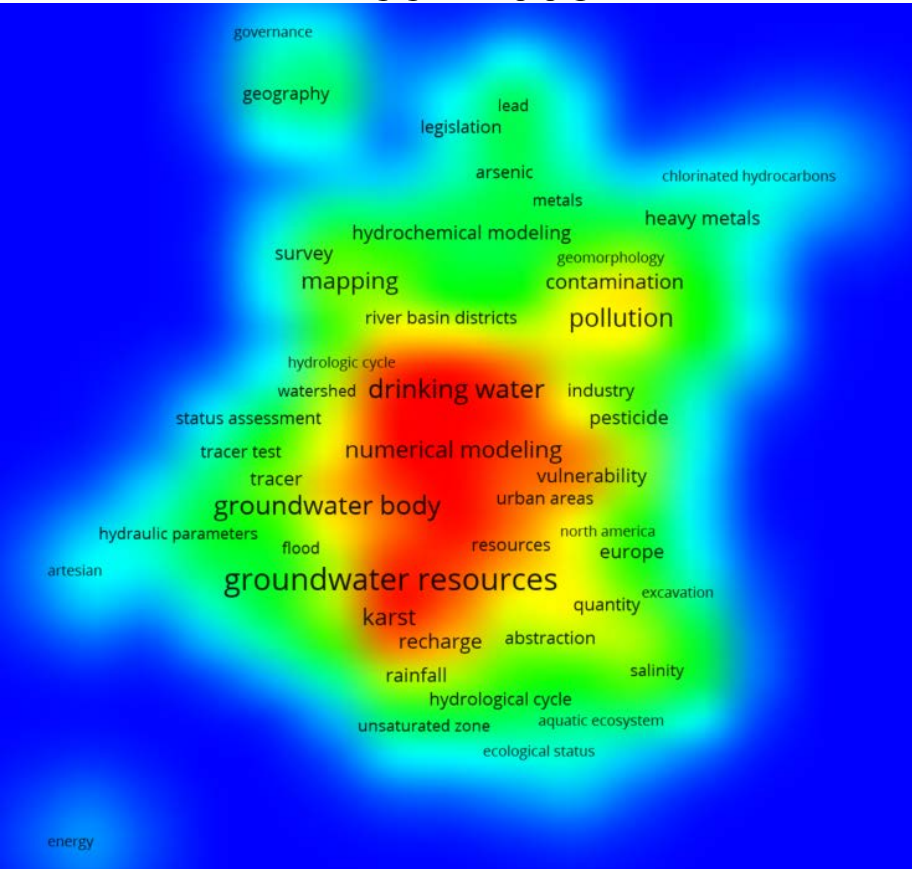
2007-2016



EIGR network graph for period 1997-2006 and 2007-2016

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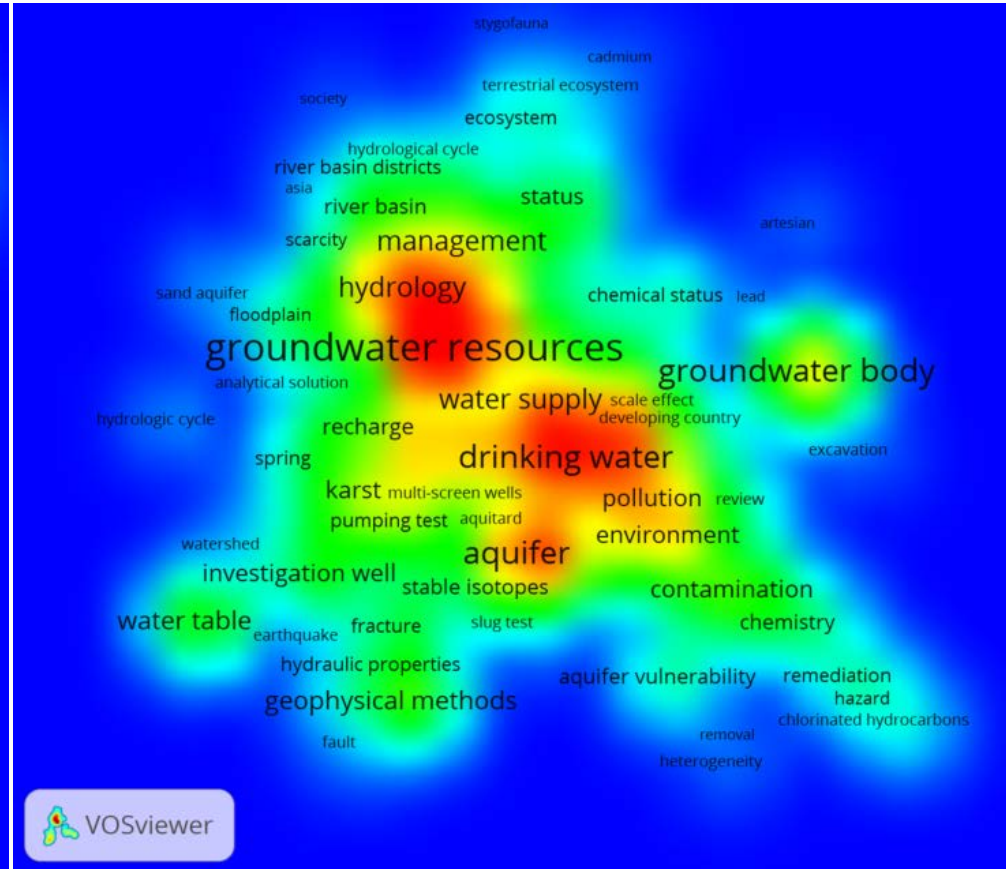
# Results: Trend analysis by VosViewer network plots for different periods, Scopus data

## 1997-2006

## 2007-2016
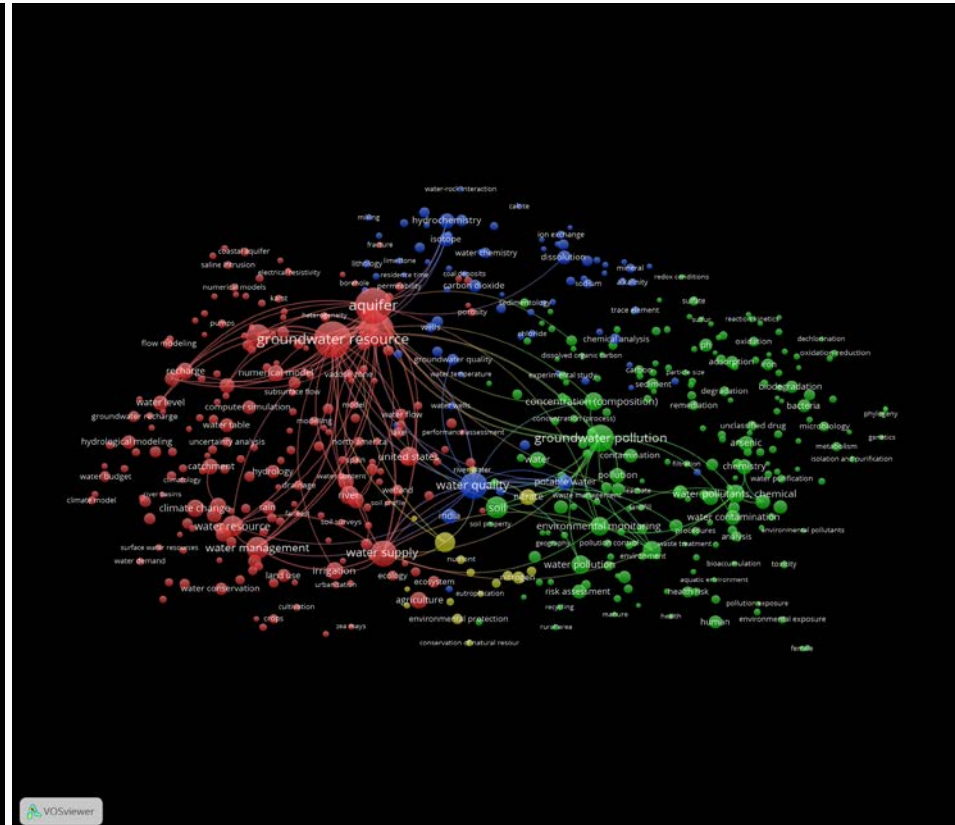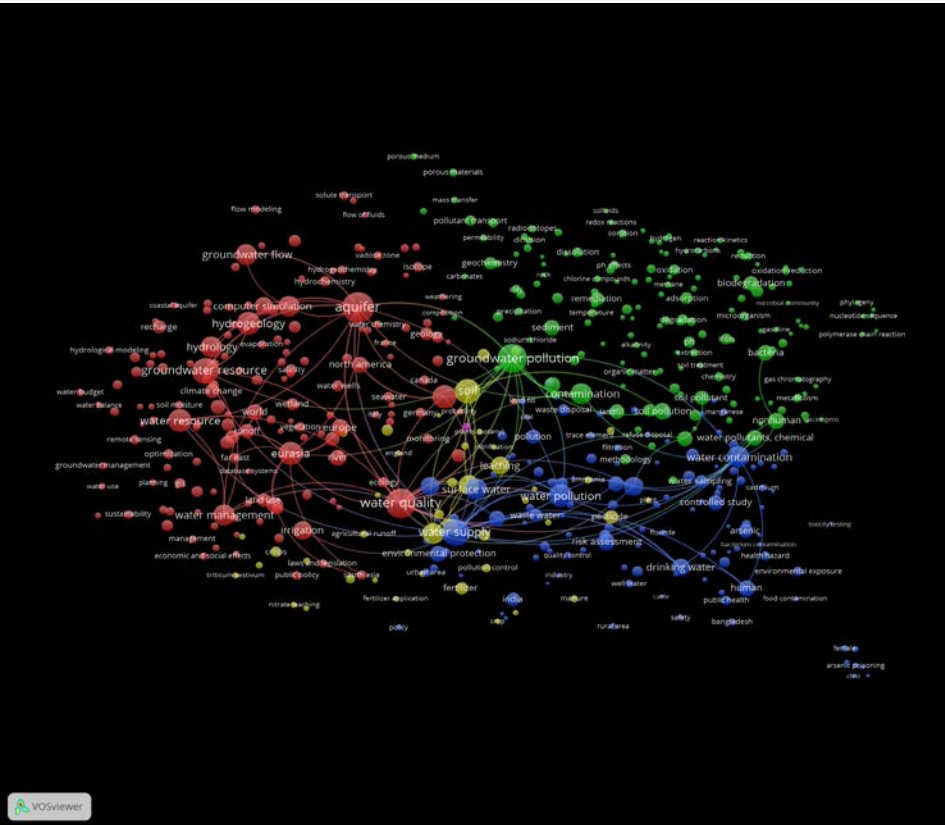


Scopus network graph for period 1997-2006 and 2007-2016

Courtesy:
Ludo Waltman,
CWTS –

EIGR network graph for period 1997-2016 and % items from a nation

# Annual number of groundwater publications in relation to "Water Science and Technology" publications, (subgroup to "environmental science" in Scopus), 1997-2017:
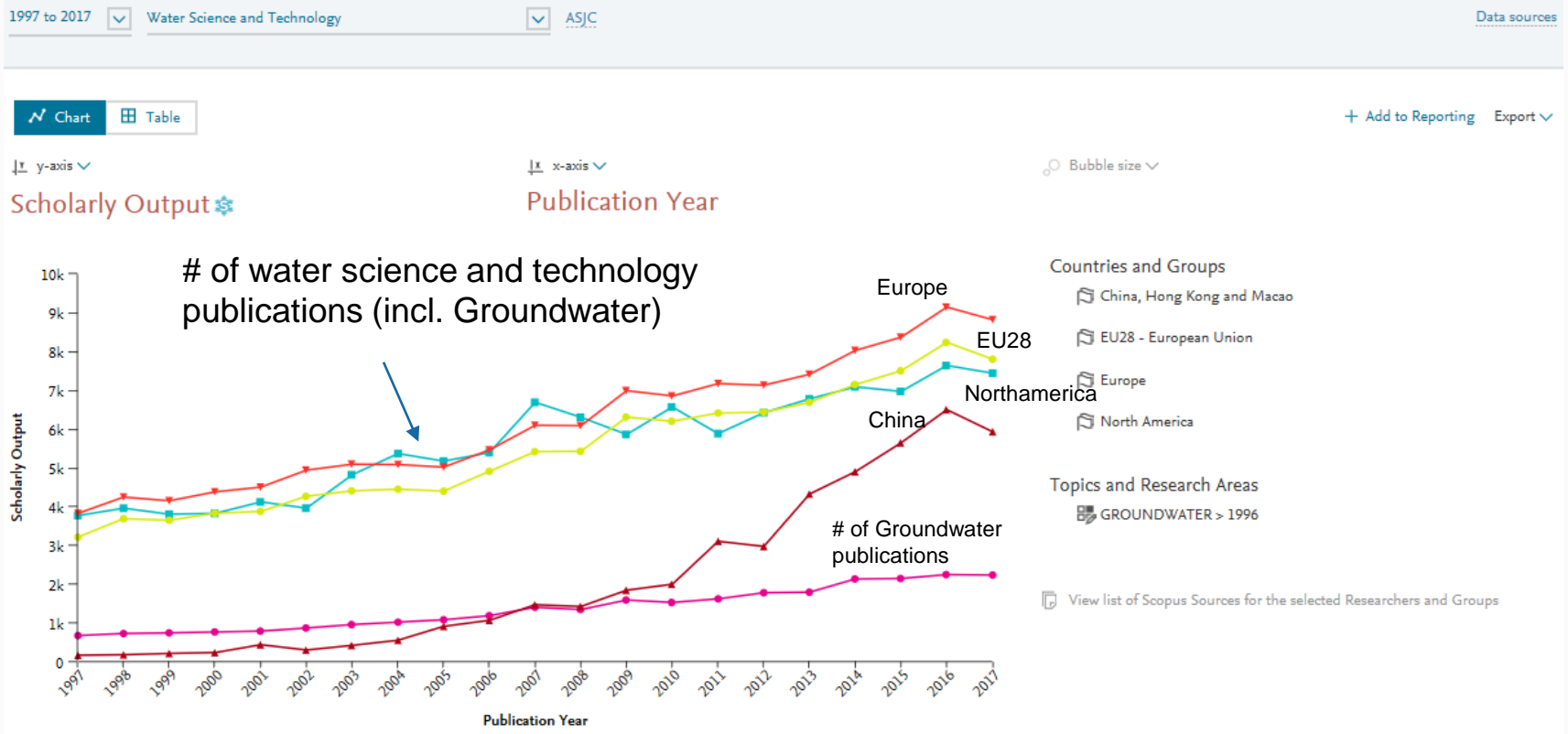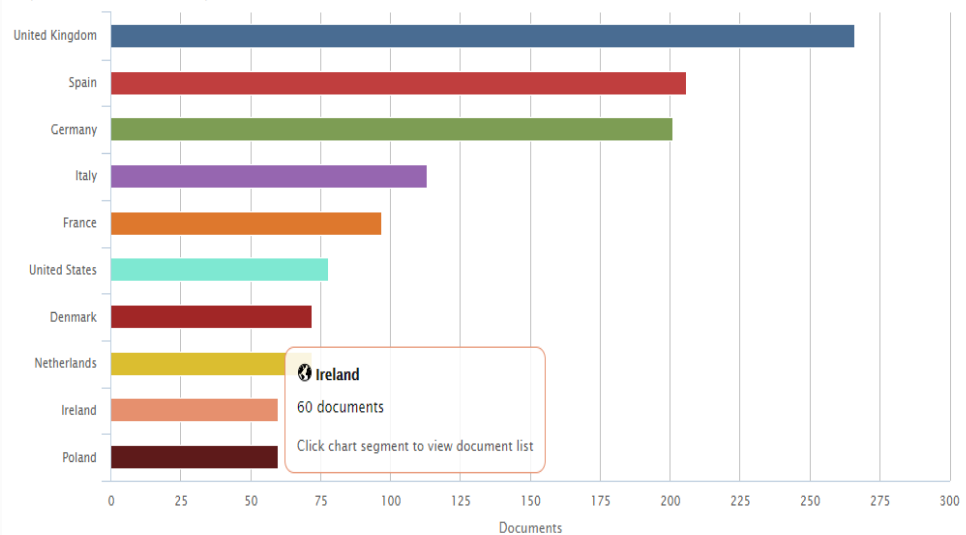
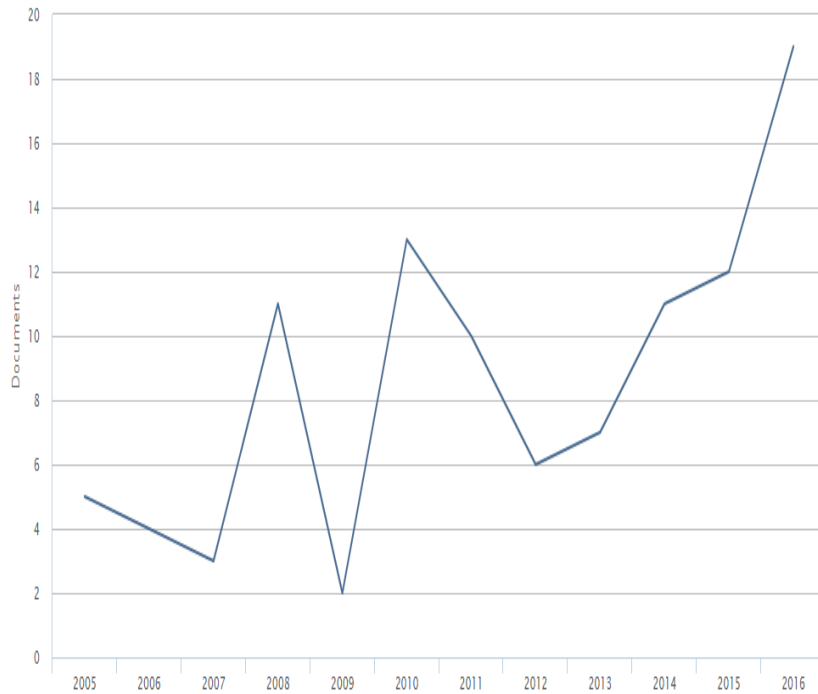# Groundwater and Water Framework Directive (1381 publications, 2000 -2016)



Documents by year
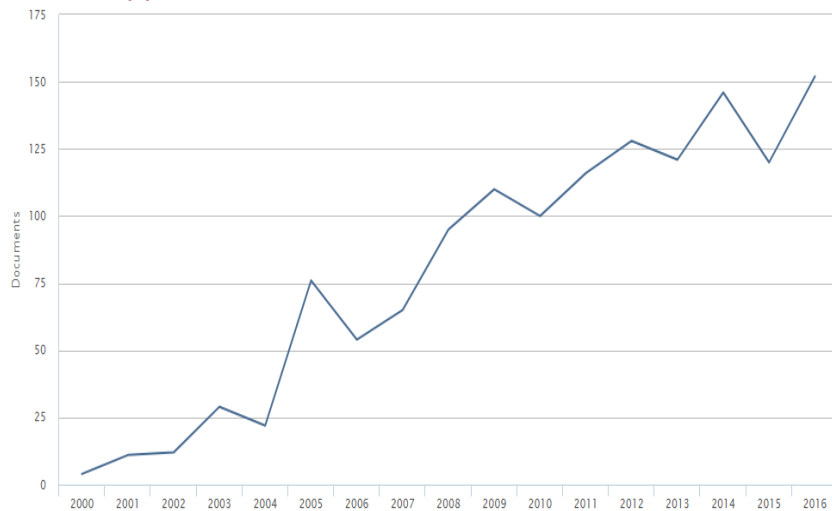


Documents by country/territory
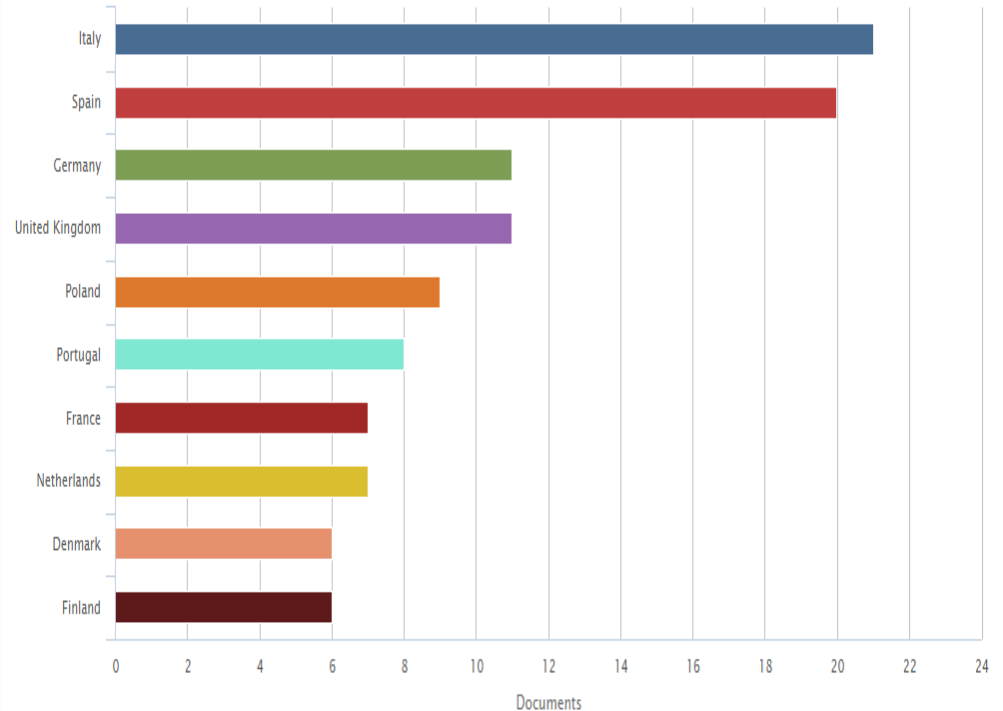Compare the document counts for up to 15 countries/territories

Ireland
60 documents
Click chart segment to view document list

# Groundwater and Groundwater Directive
## (103 publications, 2005 -2016)
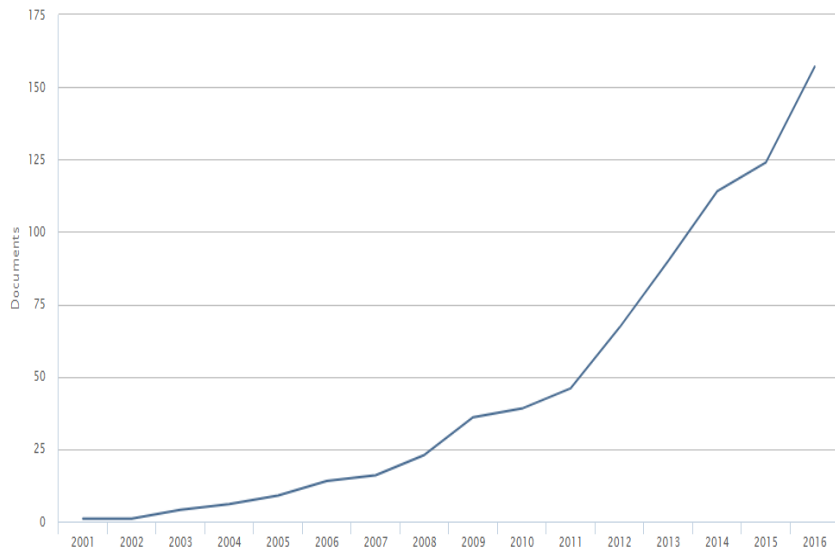


Documents by year



Documents by country/territory
Compare the document counts for up to 15 countries/territories
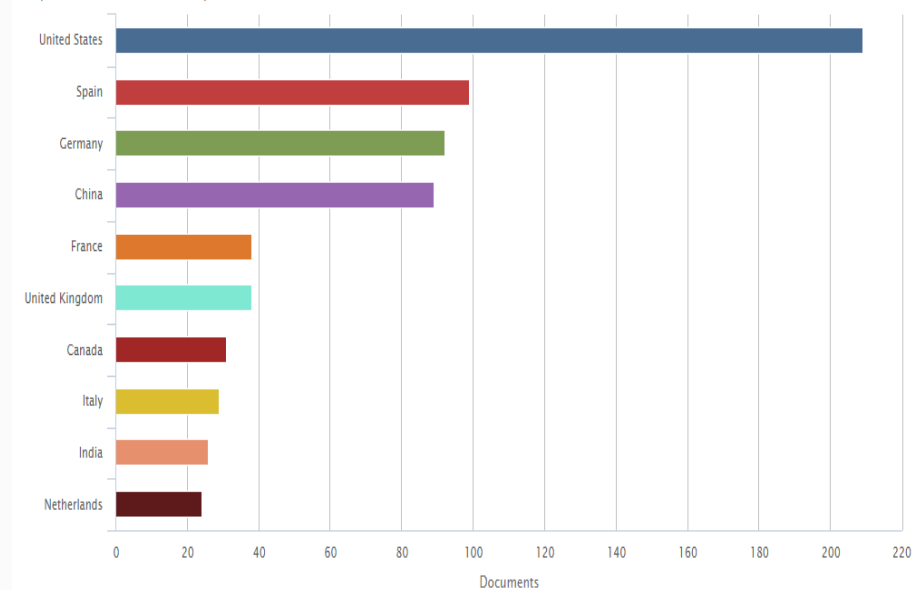
# Groundwater and "emerging contaminants" or "emerging pollutants" (747 publications, 2001-2016)



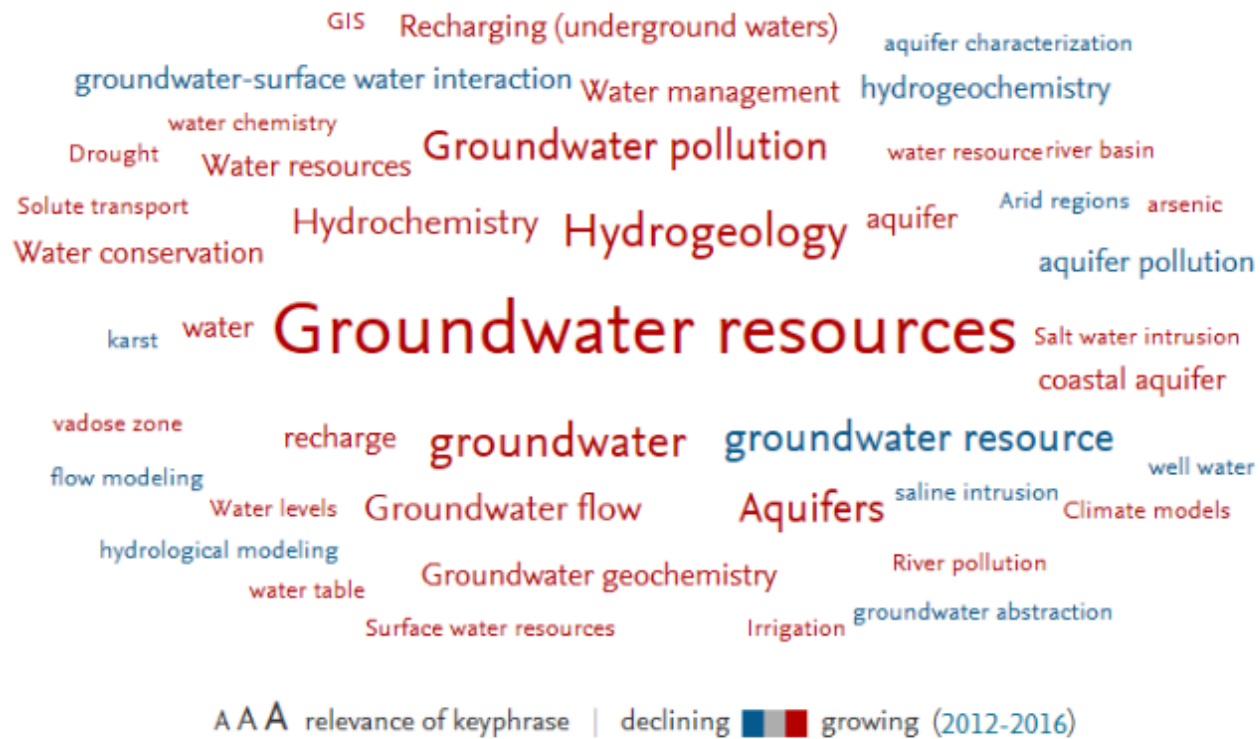Documents by year



Documents by country/territory
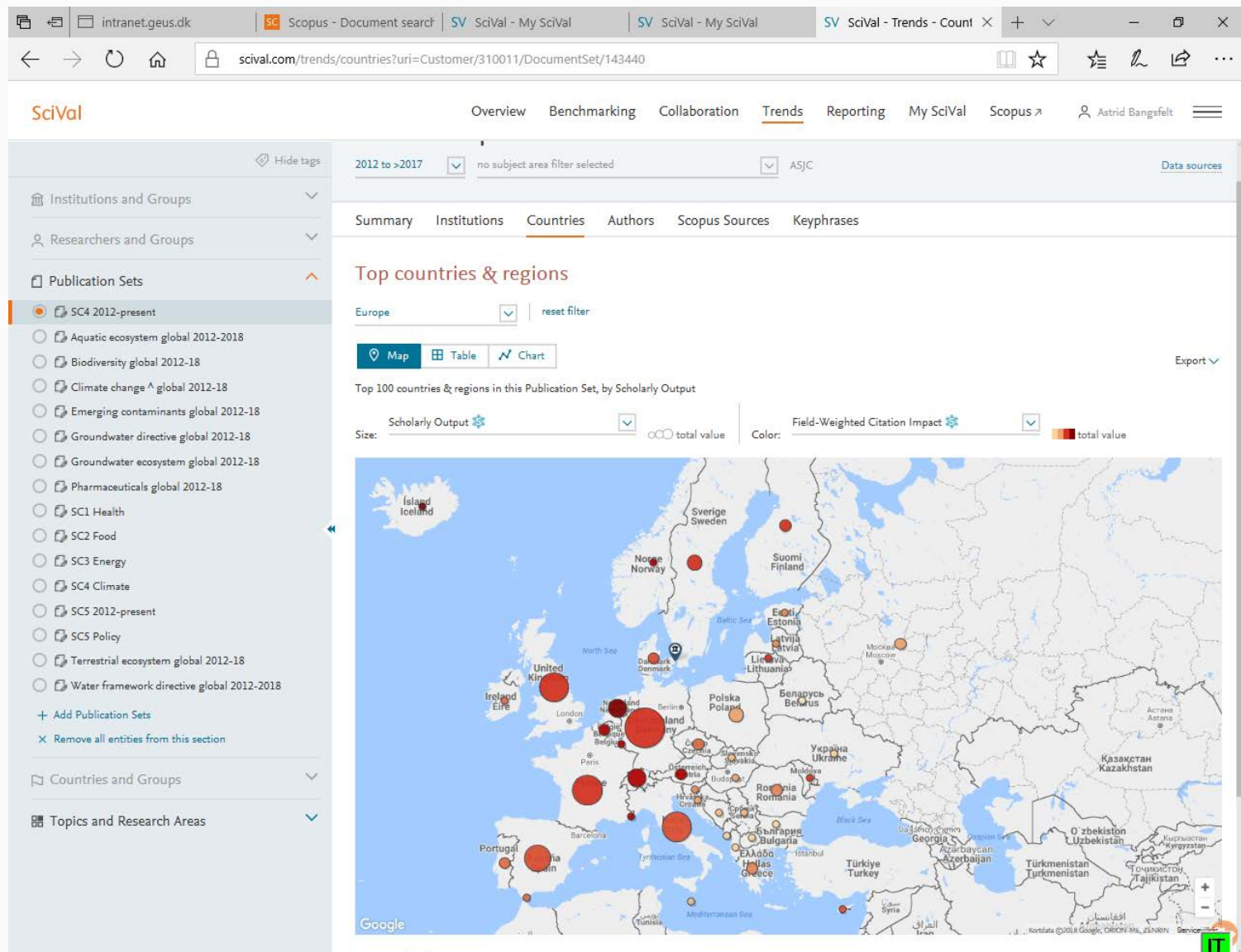Compare the document counts for up to 15 countries/territories

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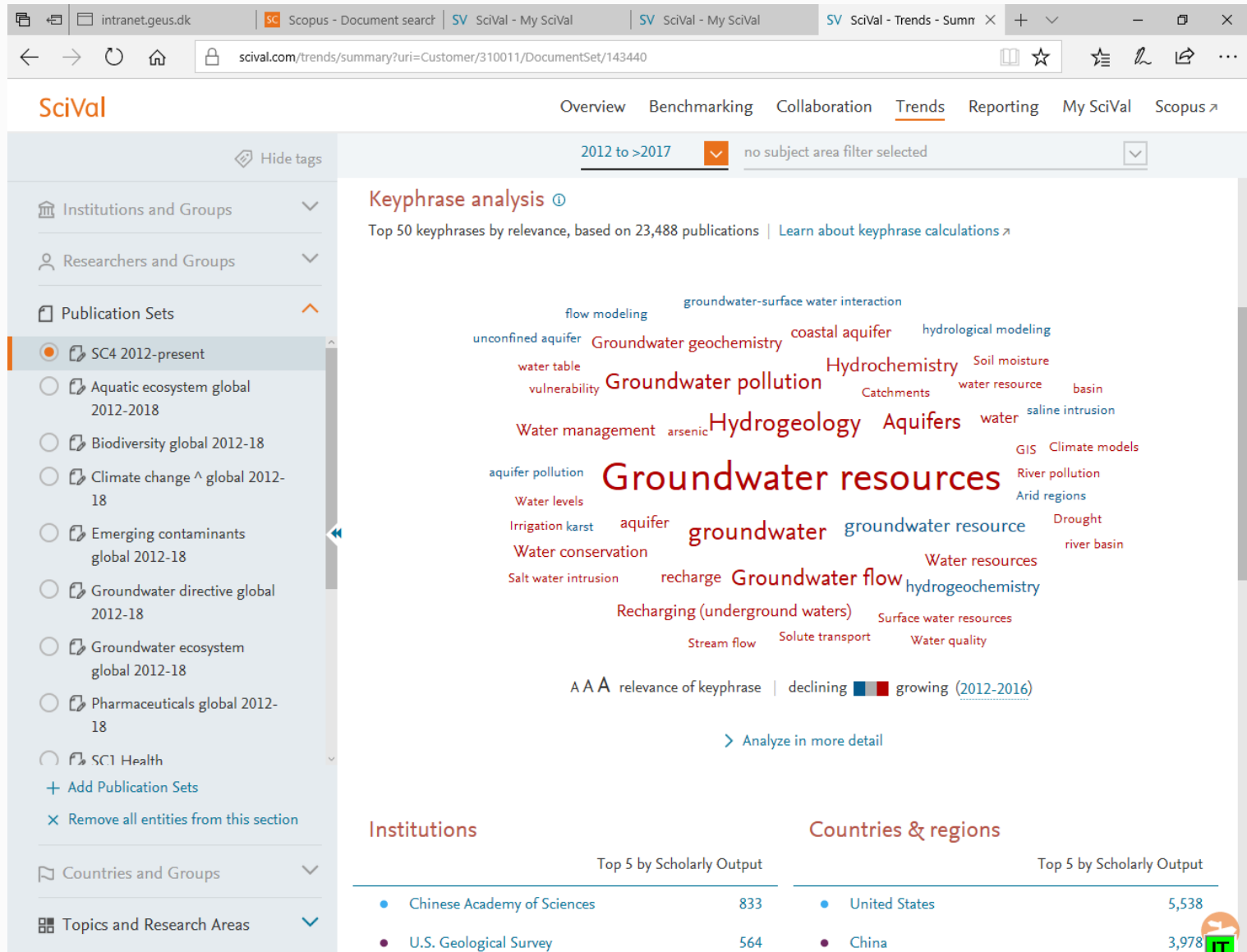
# SC4 – Climate, environment and resources

# SC4 – Climate, environment and resources, scholarly output, 2012-2018

# SC4 – Climate, environment and resources 2012-2018 wordcloud

# Observations and conclusions from EIGR and Scopus analyses of groundwater research and knowledge – some examples (1)

GENERAL OBSERVATIONS ON SCHOLARLY OUTPUT / # OF PUBLICATIONS

- The highest number of publications within societal challenges is for **SC4: Climate, environment and resources** - being the most dominant both in EIGR and Scopus – but significant amounts of research is conducted within all SCs according to Scopus
- The highest number of publications in Scopus within Operational Actions is for **OA5: Assessment and Management**
- The highest number of publications in Scopus within Research Topics is for **RT3: Geography** - (EIGR is significantly biased towards geology due to EIGR population by EFG experts)
- The scholarly output / number of **class 1 and 2 publications in a global assessment is highest for total Europe, with EU28 second**, Northamerica third and China fourth according to Scopus
- The Water Framework and Groundwater directives are drivers for groundwater research in Europe, but there's room for improvement

*NOTE! Not all observations and conclusions are supported by illustrations shown in the presentation*

# Observations and conclusions from EIGR and Scopus analyses of groundwater research and knowledge – some examples (2)

OBSERVATIONS ON TRENDS IN GROUNDWATER RESEARCH
- Groundwater **research increases significantly during the past 20 years** and nearly half of this increase generally occurred during the past five years
- The increase is **highest in China**
- Research on some issues **e.g. emerging contaminants** increases more than for other research topics

OBSERVATIONS ON GAPS IN GROUNDWATER RESEARCH e.g. IN RELATION TO WFD IMPLEMENTATION
- EIGR has **added value by including Class 3+4 knowledge** which to some extent can cover identified research gaps, but population still too small for making strong inferences.
- The method of **inspecting intersections of Research Topics and Operational Actions for different Societal Challenges gives insight in where gaps may occur**, but expert elicitation and judgements on how to infer and apply such information is needed

- Emerging contaminants is a strong/hot new research topic in Europe, China and the USA etc. Highly cited papers e.g. from the UK (BGS) – however, research and monitoring is only conducted in a limited number of countries
- Publication analyses confirms that studies on **groundwater threshold values (TVs)** established to ensure good status of groundwater dependent terrestrial or groundwater associated aquatic ecosystems according to the Water Framework and Groundwater directives are very limited. This support results from assessments performed by Working Group Groundwater of the Common Implementation Strategy for the Water Framework Directive.

*NOTE! Not all observations and conclusions are supported by illustrations shown in the presentation*

**Thank you for listening** ☺

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