Introduction

Arika Virapongse
Principal, Middle Path EcoSolutions
Webinar series coordinator, ESIP
av@middlepatheco.com

The Information Pathway for Earth Science Data: Between Supplier and User

August 7, 2018 | Webinar #2

Background

Second webinar in our series, “The Socioeconomic Value of Earth Science Data, Information, and Applications”

Main points

- Concepts behind the transference and usage of data and tools (information pathway) as they move between suppliers and end users.
- The demands between these two ends of this path can be leveraged to produce better tools and more useful information.
- Different tools are available to understand, analyze, and streamline the information pathway.

Structure for the webinar

Panel Presentations

Andrew Coote

ConsultingWhere

"Applying Value Chain Techniques to Economic Assessment of 3D Geo-information"

Dr. Emily Pindilli

U.S. Geological Survey

"Using Decision Trees to Estimate the Value of Streamgages"

Danny Vandenbroucke

KU Leuven

"Improving access to Earth Science data from Copernicus"

Applying Value Chain Techniques to Economic Assessment of 3D Geo-information

Andrew Coote
ConsultingWhere Ltd

Agenda

- Introduction
  - Case Study
  - Valuing Information
- Value Chain Analysis Methodology
- Deliverables
- Conclusions

Introduction

- This work formed part of a continued widening of the EuroSDR research agenda to cover business themes in addition to technical topics

- Making an economic appraisal of value of 3D geo-information *per se* is not possible, it is first necessary to identify the use cases to which the information contributes.

- The first step for each use case is to understand the **value chain** – the "actors", the data they produce and through what processes it becomes actionable information.

- Quantification of impacts (costs and benefits) is then possible focusing on the most significant value adding processes.

Valuing Information

- Unless information is applied it has little or no value.
- We should not confuse the value of information with the value of benefits from policies and/or systems that use it in decision making
- There is almost always alternative evidence to support decisions (economists call this the "counterfactual"):
  - No change, continue as now (*status quo*)
  - Other data sources (increasing in a world of data abundance)
- It follows that an information source is only worth the difference in value between it and the next best alternative

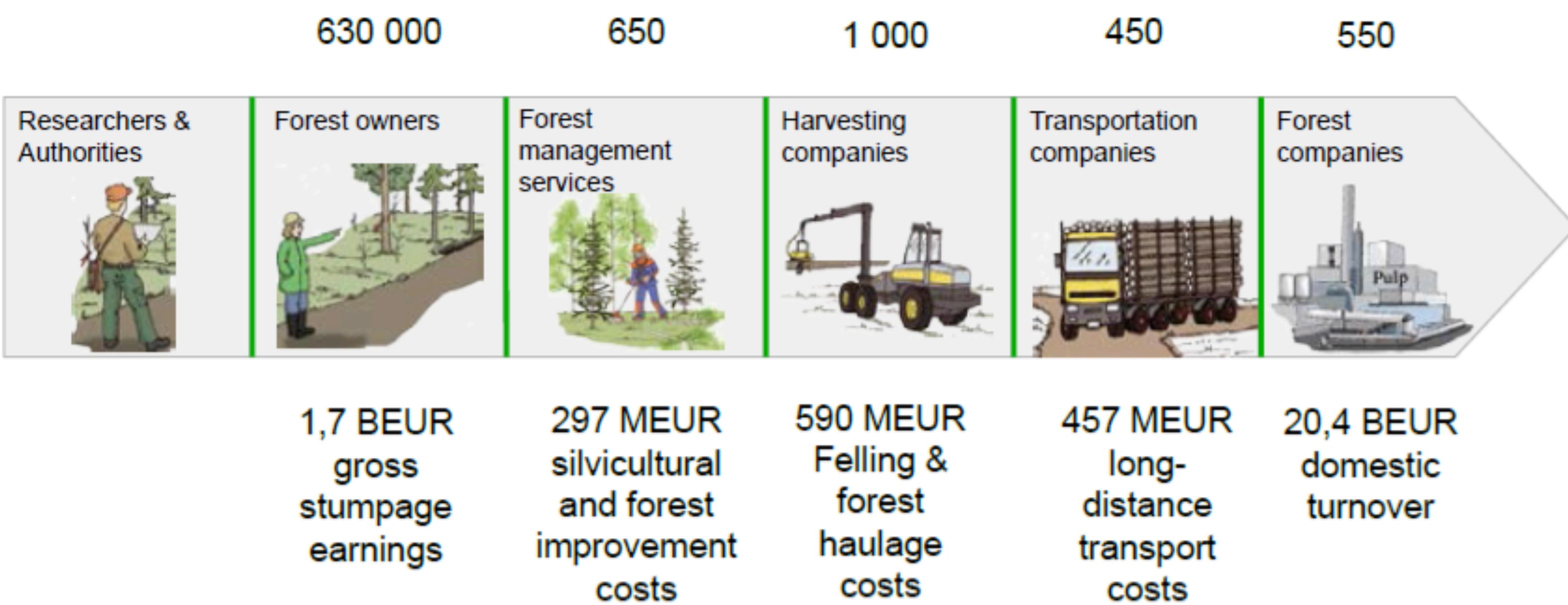
Value Chain Analysis

What is a Value Chain?

- A value chain describes the flow of interactions between organisations and how they contribute to the provision of services used by businesses and consumers.

- It describes how and where value is added at different stages in the supply chain, beginning with providers of raw materials through to distributors of the final product.

Simple example: Timber Procurement Value Chain



Source: Potential Business Models for Forest Big Data, Metsahteo, Finland 2014

Selected Use Cases for 3D Geo-information

- Forestry Management
- Urban Planning
- Flood management
- Asset management – Smart Cities
- Resilience – public safety and security
- Cadastre and Valuation

Methodology

- Engagement with wide range of stakeholders including private sector and consumer groups
- Intensive interactive full day workshop with “opinion-formers” with emphasis intermediary and end user participation
- Value chain modelled at high level with objective of identification of processes where 3D geospatial information would have greatest social and / or economic impact.
- Scoring of High Impact processes based on alignment to political priorities.

Value Chain Deliverables

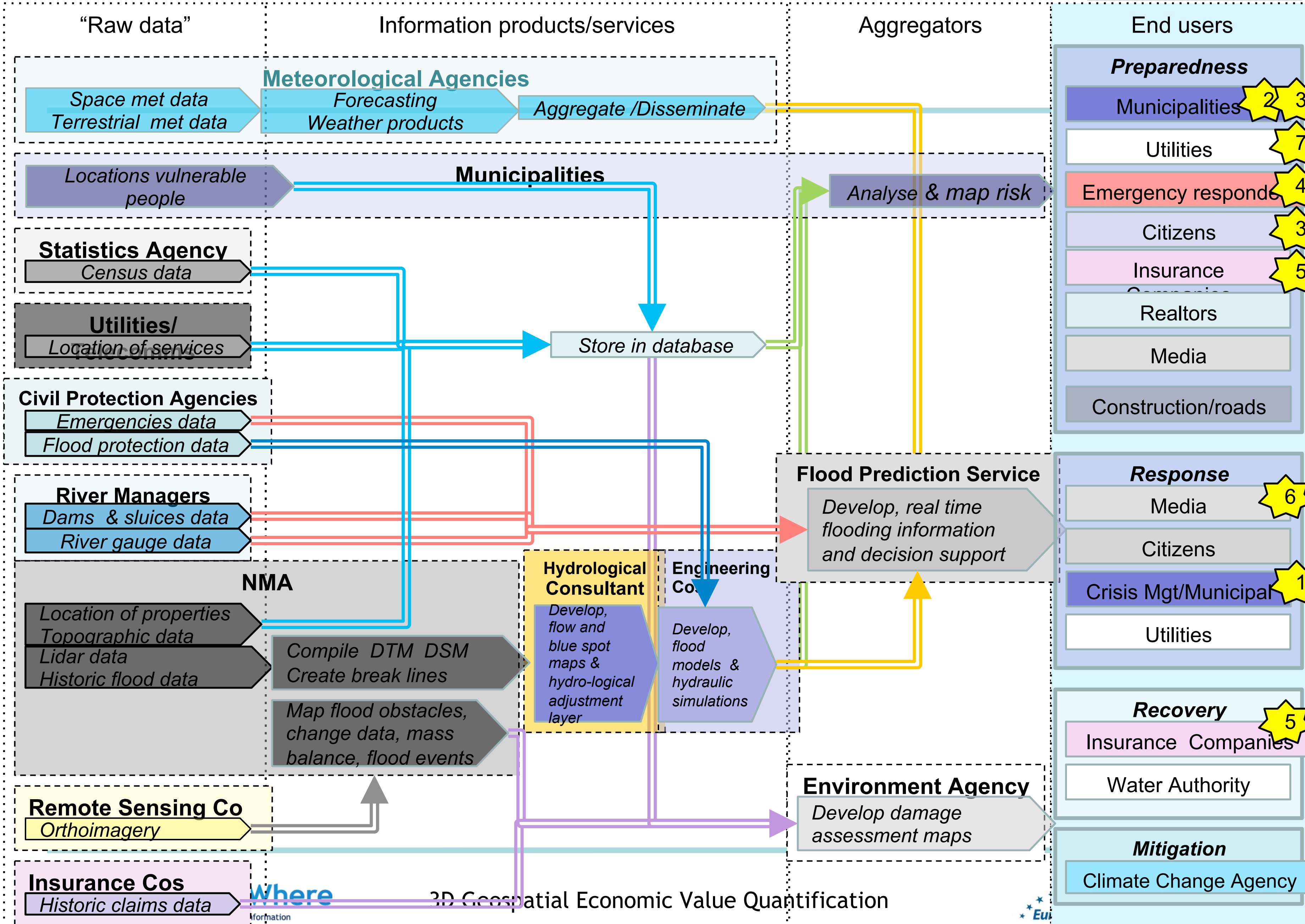
- Executive Summary

- Value Chain Diagrams
- Ranked Benefits Schedule

- Presentations, References for further study
- Glossary

Flood Management - Value Chain

Note: coastal and marine not included



Ranked Benefits Schedule – Flood Management

Ref	Actor	Process	Benefit	Score
1	Crisis Management Group	Flood early warning systems allows for emergency services and local authorities to take short term flood mitigation actions to save lives and property.	Increased public safety Reduce loss of life / injury and damage to property.	17
2	Municipalities (Zoning and Development planning)	Improved flood risk map accuracy improves confidence in the legitimacy of flood risk assessments. More effective local strategic planning (10-20 years ahead) to mitigate future flood risk.	Reduced loss of business and interruption to services. Improved risk awareness for decision makers Preservation of the natural function of floodplains.	8
3	Municipalities (Development and Construction Control)	Improved tools for risk analysis in the strategic planning of construction are quicker to use and easier to justify this leads to savings in administrative costs (e.g. in dealing with appeals) and resources.	Administrative cost savings.	8
4	Emergency Responders	Putting the assets for disaster relief in the right place. More efficient allocation in planning leads to more effective response.	Improved Resource Deployment Quicker Response Times	4
5	Insurance Companies	Accurate insurance premiums for high and low risk areas. Accurate elevation data is required for individual property insurance risk assessment and calculating risk based premiums.	More accurate risk analysis increases insurance provider confidence when setting premiums allowing for more competitive premiums for some customers.	3
6	Media	Citizen/Business awareness of flood risk is improved by the availability and communication of accurate flood risk maps. Communication is particularly effective is 3D visualisations are used.	Provide earlier flood warning Advice on minimising damage to property.	3

Conclusions

- Value chain analysis is a quick and effective technique for identification of key socio-economic impacts of technological change, such as 3D geo-information models.
- The highest areas of value adding were predominantly in the demand-side processes of data aggregation and consumption by end users.
- Often these processes are poorly understood by suppliers, pointing to an ingrained belief that “if you build it, they will come”.

Further Information

Assessing the Economic Value of 3D Go-information –EuroSDR Research Report:

http://www.eurosdr.net/sites/default/files/uploaded_files/pub68_economicvalue-3d-geo-information_final_v1.pdf

GeoValue – Community of Practice

Website: www.geovalue.org

Book: The Socioeconomic Value of Geospatial Information

https://www.crcpress.com/GEOValue-The-Socioeconomic-Value-of-Geospatial-Information/Kruse-Crompvoets-Pearlman/p/book/9781498774512

Panel Presentations

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ConsultingWhere

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Using Decision Trees to Estimate the Value of Streamgages

Emily Pindilli

Science and Decisions Center

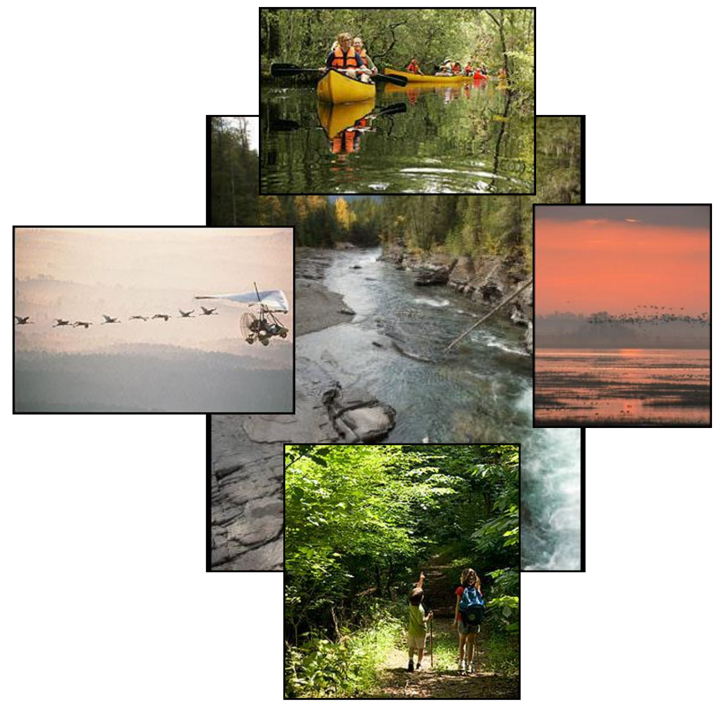
U.S. Geological Survey

August 7, 2018

USGS

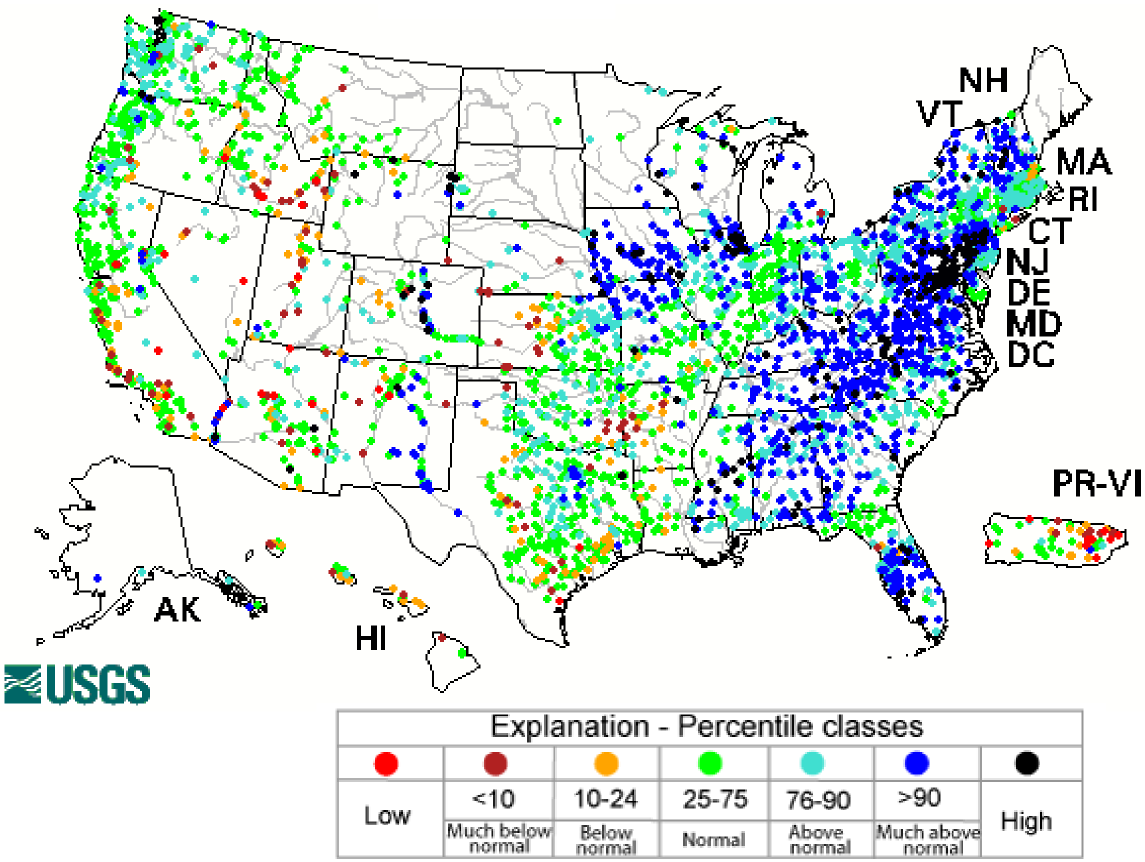
- Science and Decisions Center (SDC) is an interdisciplinary group advancing the use of science in natural resource decision making.

- SDC works across 5 themes:
  - Natural resource economics
    - Environmental markets
    - Valuing natural resources
    - Valuing scientific information
  - Ecosystem services
  - Decision science
  - Participatory science and innovation
  - Resilience



Streamgages Provide Critical Information

Real-time Streamflow Information



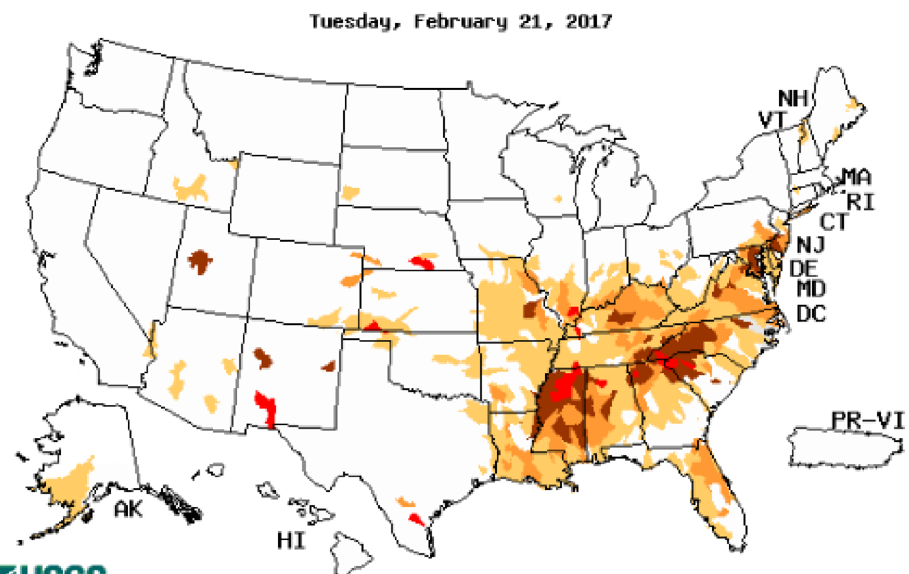
USGS Streamgage Network

- USGS network in operation since 1889
- National network of 7,600 gages
- Provides real-time and historical data on stream stage (height) and flow
- Information is readily and freely available

Predicting Droughts

Map of below normal 7-day average streamflow compared to historical streamflow for the day of year (United States)

State ▾

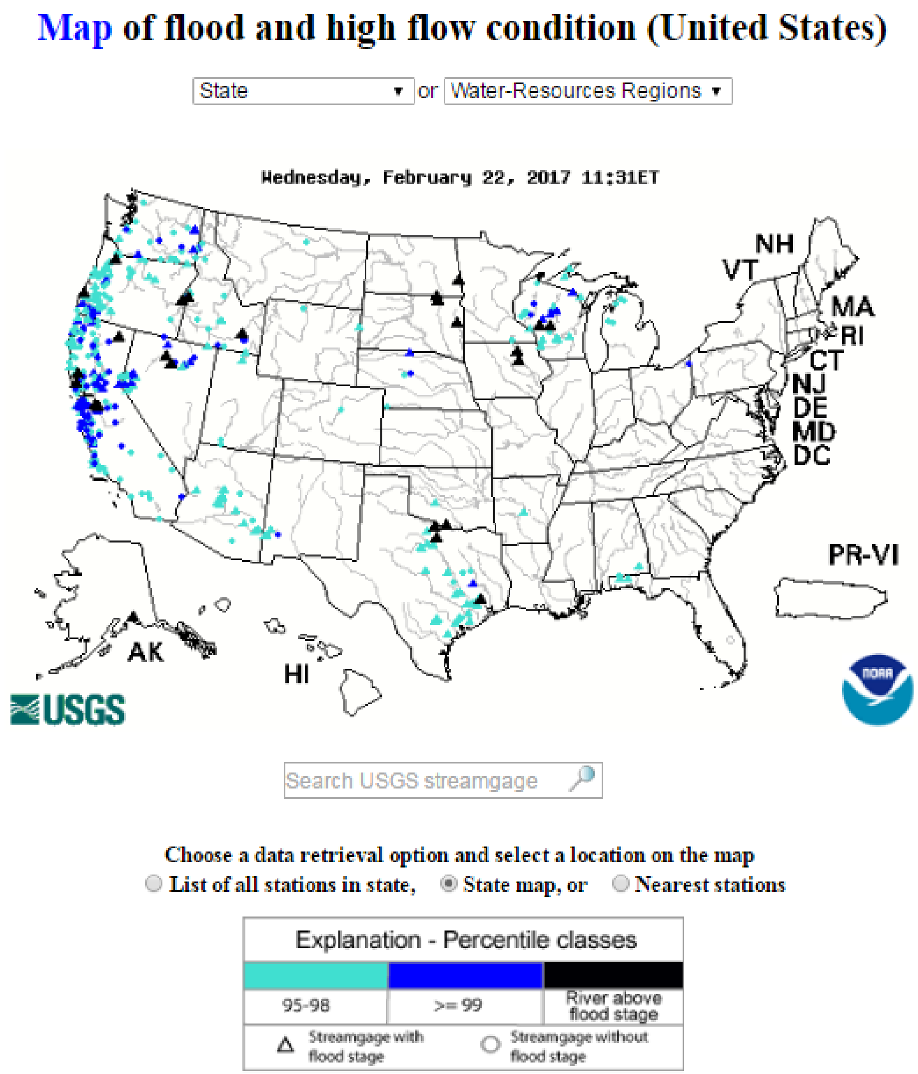


Choose a data retrieval option and select a state on the map

○ State DroughtWatch, ◉ State map

Explanation - Percentile classes				
Low	<=5	6-9	10-24	Insufficient data for a hydrologic region
Extreme hydrologic drought	Severe hydrologic drought	Moderate hydrologic drought	Below normal	

Forecasting Floods



Hazards


Photo: USGS


Photo: USGS

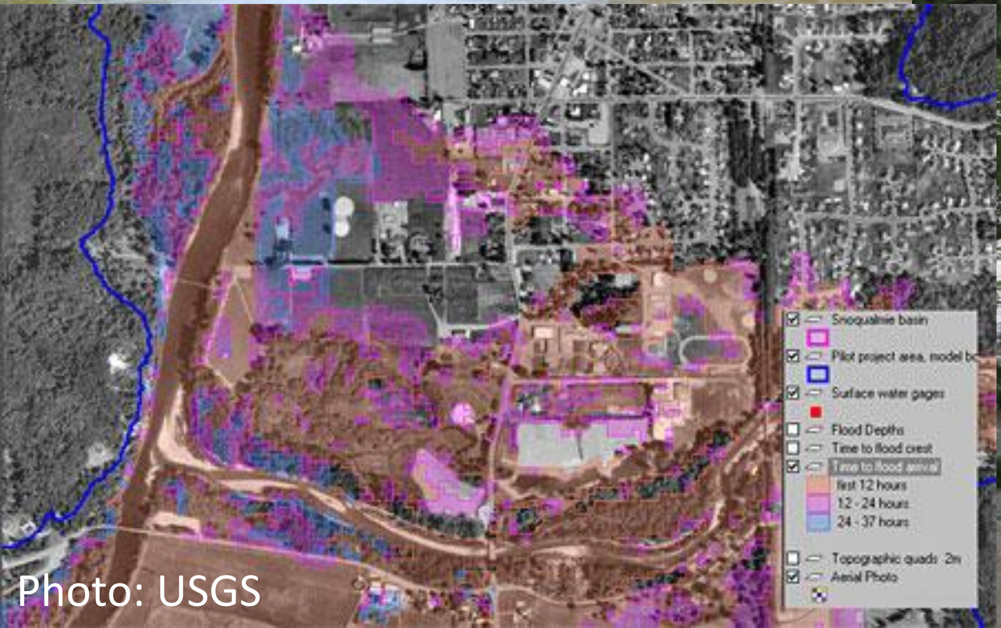

Snoqualmie basin
Pilot project area, model b
Surface water gages
Flood Depths
Time to flood crest
Time to flood arrival
first 12 hours
12 - 24 hours
24 - 37 hours
Topographic quads 2m
Aerial Photo
Photo: USGS


Photo: USGS

Infrastructure


Photo: USGS


Photo: DC Water


Photo: USGS


Photo: USGS

Water Allocation

Photo: USGS


Photo: USGS

Photo: USGS


Photo: USGS

Water Quality

Photo: USGS

Photo: USGS

Photo: USGS

Photo: USGS

Navigation and Recreation

Photo: USGS

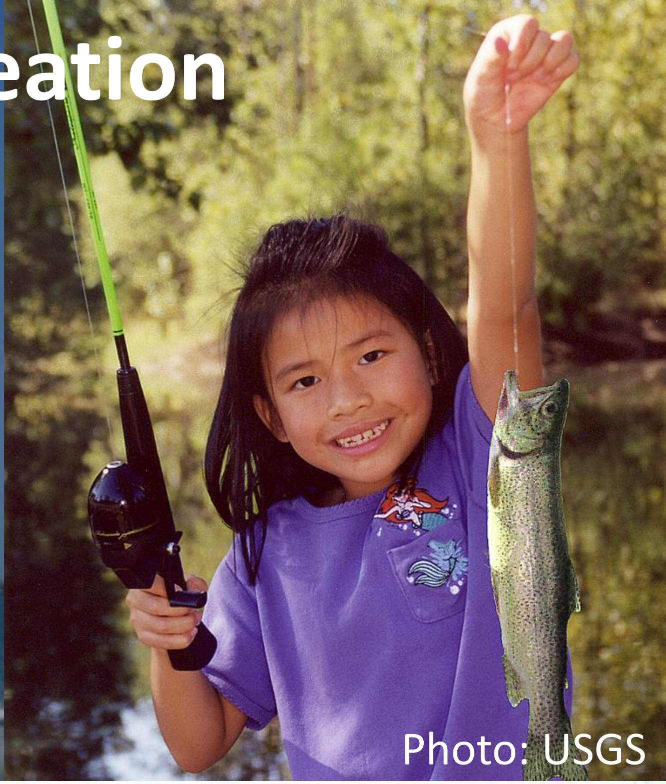


Photo: USGS

Photo: USGS

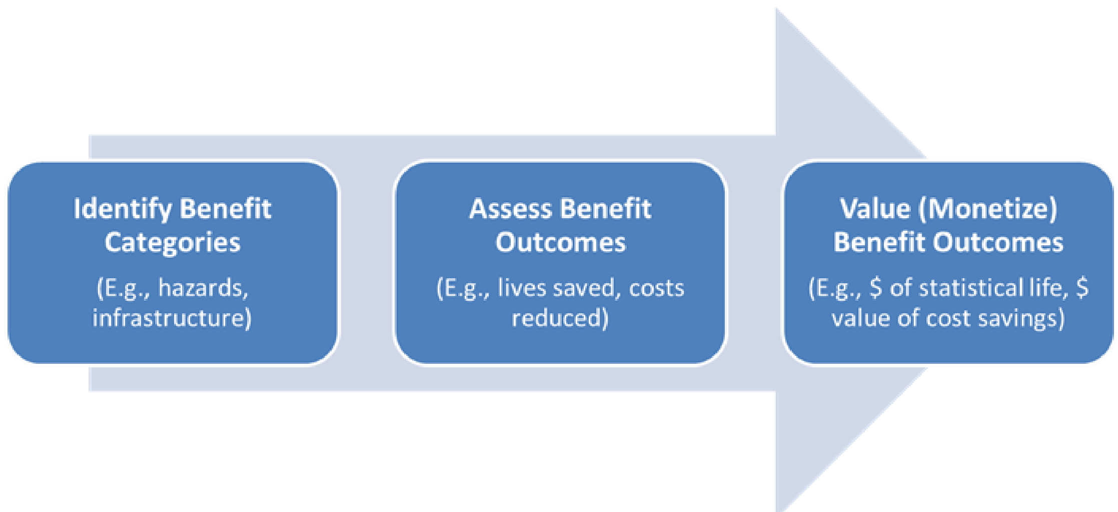
Photo: US Army Corp of Engineers

The Value of Benefits is Being Assessed

Application-by-Application Approach

- Benefits are being analyzed by application
- Monetization is focused on high magnitude impacts
- Values are aggregated to provide Total Economic Value*

*aggregated value will not capture 100% of benefits



USGS

Culverts are Engineered to Protect Infrastructure

- A culvert is an engineered structure, i.e., a pipe, which is partially buried to allow surface water to flow underneath a roadway

- Engineering design relies on hydrology and hydraulics
  - Area precipitation
  - Over- and through-flow of surface water
  - Fluctuations in flow of river
  - Mechanics of water impact on structure

Example of a Culvert

Information is Needed to Design Culvert Capacity

- Water flow under various conditions must be derived to estimate capacity
  - Flow varies seasonally and annually

- Stream physical characteristics indicate ‘normal’ conditions; not flow for events which occur less frequently

- **Research Hypothesis:** increase in information (streamgage observations, in particular peak streamflow) will lead to optimization of culvert hydraulic capacity

Not all Information is Equivalent

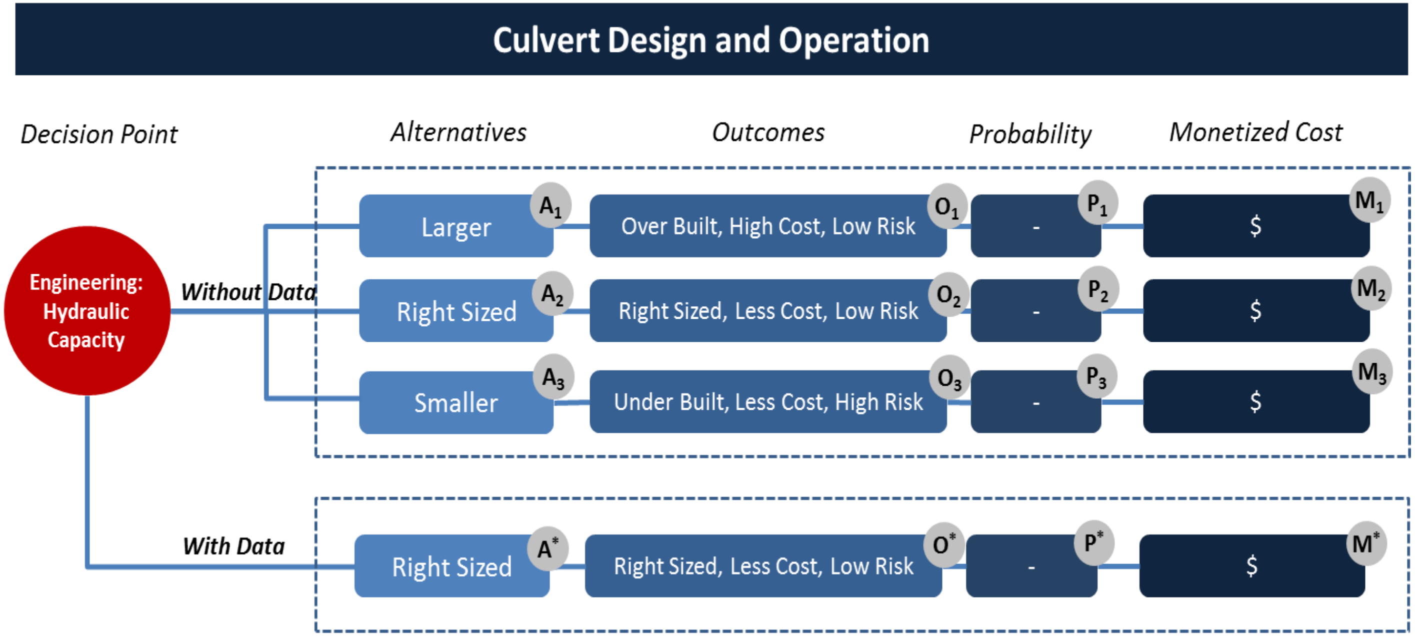
Increasing Information

Bankfull Information	Regression Equations	Onsite Streamgage Data
• Early approaches relied heavily on bankfull measures and coefficients[1] • Study found bankfull data provides ~1.77 year storm recurrence; standard error of 51 percent for 100-year storm[2] • Another study estimated bankfull data only provides meaningful estimates of five-year storm or less[3]	• Relying on streamgages on similar stream segments with similar watershed characteristics • Availability varies with availability of similar watershed • Confidence varies with likeness of watershed	• Actual observations provides "best" (highest confidence) information • Confidence in accuracy flow during different recurrence events varies with streamgage history length

1. McEnroe, Bruce M. (2007). *Sizing of Highway Culverts and Bridges: A Historical Review of Methods and Criteria.* The University of Kansas, Report No. K-TRAN: KU-5-4.
2. U.S. Geological Survey (USGS). (2005). USGS. *Bankfull Characteristics of Ohio Streams and Their Relation to Peak Streamflows:* Scientific Investigations Report # 2005-5153. Available at: http://pubs.usgs.gov/sir/2005/5153/pdf/Bankfull_book.pdf
3. Wharton, G., N.W. Arnell, K.J. Gregory, and A.M Gurnell. (1989). *River Discharge Estimated from Channel Dimensions*. Journal of Hydrology. Volume 106 (3-4). 365–376 p.

Deriving the Value of Streamgage Information: Bayesian Decision Trees

"Any one can make a culvert large enough, but it is the province of the engineer to design one of sufficient but not extravagant size"[1]



The Value of Information (VOI) can be derived from the decision tree as follows:

$$|(P^* \times M^*) - [(P1 \times M1) + (P2 \times M2) + (P3 \times M3)]| = VOI$$

1. Byrne, A.T. (1902). *A Treatise on Highway Construction,* fourth edition.

Analysis is Grounded in Research, Previously Collected Data

- Extensive Literature Review
  - Use of streamgage data for infrastructure
  - Culvert design, engineering, and operations
  - Incidence of blowouts, overtopping events, and other failures

- Outreach to Transportation Engineering Community
  - Department of Transportation Federal Highway Administration (Office of Bridges and Structures, Culvert Hydraulics Resource Center, Climate Adaptation Program)
  - Army Corp of Engineers
  - Academia (University of South Alabama, Colorado State University)
  - State Department of Transportations (Utah, Nebraska, Virginia, Vermont, Ohio, Connecticut)
  - Transportation Research Board
  - American Society of Civil Engineers
  - Engineering Consultants

- Outreach to Disaster Response Entities
  - Federal Emergency Management Agency (midwest region and national office)
  - Fish and Wildlife Service National Fish Passage Coordinator

Outcomes of Decision Paths are Quantified

- Overbuilt
  - Cost of construction and installation will outweigh benefits of risk reduction
  - Ohio DOT reported that new USGS regressions showed some culverts are oversized[1]

- Right sized
  - Construction and installation costs will equal damages avoided

- Underbuilt
  - Damages incurred due to insufficient hydraulic capacity on a periodic basis
  - Damage categories:

Direct Impacts	Costs	Variables
Flooding of adjacent property	Property damage (crops) Property damage (buildings)	Types of crops, value of crops Types of buildings, value of buildings and contents
Roadway flooding damage	Damage to pavement Damage to embankment	Material costs, labor costs Material costs, labor costs
Interruption of traffic	Increased travel time Increased travel distance	Duration of disruption Distance to avoid disruption Average daily traffic
Hazard to human life	Injury Value of a statistical life	Magnitude of injury Average daily traffic
Damage to stream and floodplain	Water quality impacts Loss of floodplain services	Damage extent, secondary impacts Types of services being impacted

1. Ohio Department of Transportation . (2013). Personal communication with Jeffrey Syar, PE, Administrator for the Office of Hydraulic Engineering in Ohio DOT.

Outcomes of Underbuilt Scenario are Monetized

- Damage costs are specified using multiple approaches:
  - Traditional cost estimation (property damage, cost of replacing pavement, embankment repairs)
  - Non-market costs use average estimated costs from authoritative sources (DOT rulemaking values) for travel time savings, travel distances, injuries and deaths
  - Values of water quality and floodplain services are highly dependent on location, not monetized in current analysis
- Economic Model is specified:

$$\text{Annual Cost Risk} = (\text{DamageCosts}_{100\text{-YearEvent}} * \text{AnnualRisk}_{100\text{YearEvent}}) + (\text{DamageCosts}_{50\text{-YearEvent}} * \text{AnnualRisk}_{50\text{YearEvent}}) + (\text{DamageCosts}_{25\text{-YearEvent}} * \text{AnnualRisk}_{25\text{YearEvent}}) + (\text{DamageCosts}_{10\text{-YearEvent}} * \text{AnnualRisk}_{10\text{YearEvent}}) + (\text{DamageCosts}_{5\text{-YearEvent}} * \text{AnnualRisk}_{5\text{YearEvent}})$$

Application of Approach

Underbuilt Only

- Utilized a dataset by the Department of Transportation[1] on the cost of damages associated with overtopping events
  - Direct measures of 21 culvert overtopping events including actual peak flow and damage costs associated with roadway and embankment (low estimate of total cost)
  - Was possible to associate 2 of the incidents with streamgages (Castor River at Zalma State Highway 51, Bolilnger County, Missouri and San Francisco River at U.S. Highway 666 at Clifton, Arizona)
  - Downloaded historical peak flows and estimated exceedence values for 100, 50, 25, 10, and 5 year storm frequencies
  - Assumed cost of damages observed for the given streamflow could be applied as the unit cost for each cubic foot per second of volume above the 2-year storm hydraulic capacity

1. Department of Transportation, Federal Highway Administration (FHWA). (1987). *Development of a Methodology for Estimating Embankment Damage Due to Flood Overtopping.* Available at: http://isddc.dot.gov/OLPFiles/FHWA/009466.pdf.

Lessons Learned

- Data, data, data – data may not be available where one might assume records are kept

- Lots of people love streamgages, but it is challenging to quantify value

- The use of data for culvert design and operations was evident in the literature and in talking with federal and state DOTs; however, it was difficult to assess the number that used actual streamgage data (onsite) versus regression equations or other alternatives

For More Information Contact:

Dr. Emily Pindilli
epindilli@usgs.gov
703-648-5732

Panel Presentations

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Co-funded by the Erasmus+ Programme of the European Union

Copernicus Value Chain

Improving the use of Earth Science data

Danny Vandenbroucke

Outline

- Context
- The Copernicus Value Chain
- Skills development
- Ongoing work

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The Copernicus Programme

- Objective
  - Stimulate the user uptake of the wealth of space data through services

"… transform the wealth of satellite and in situ data into value-added information by processing and analysing the data …"

(Copernicus.eu, 2018)

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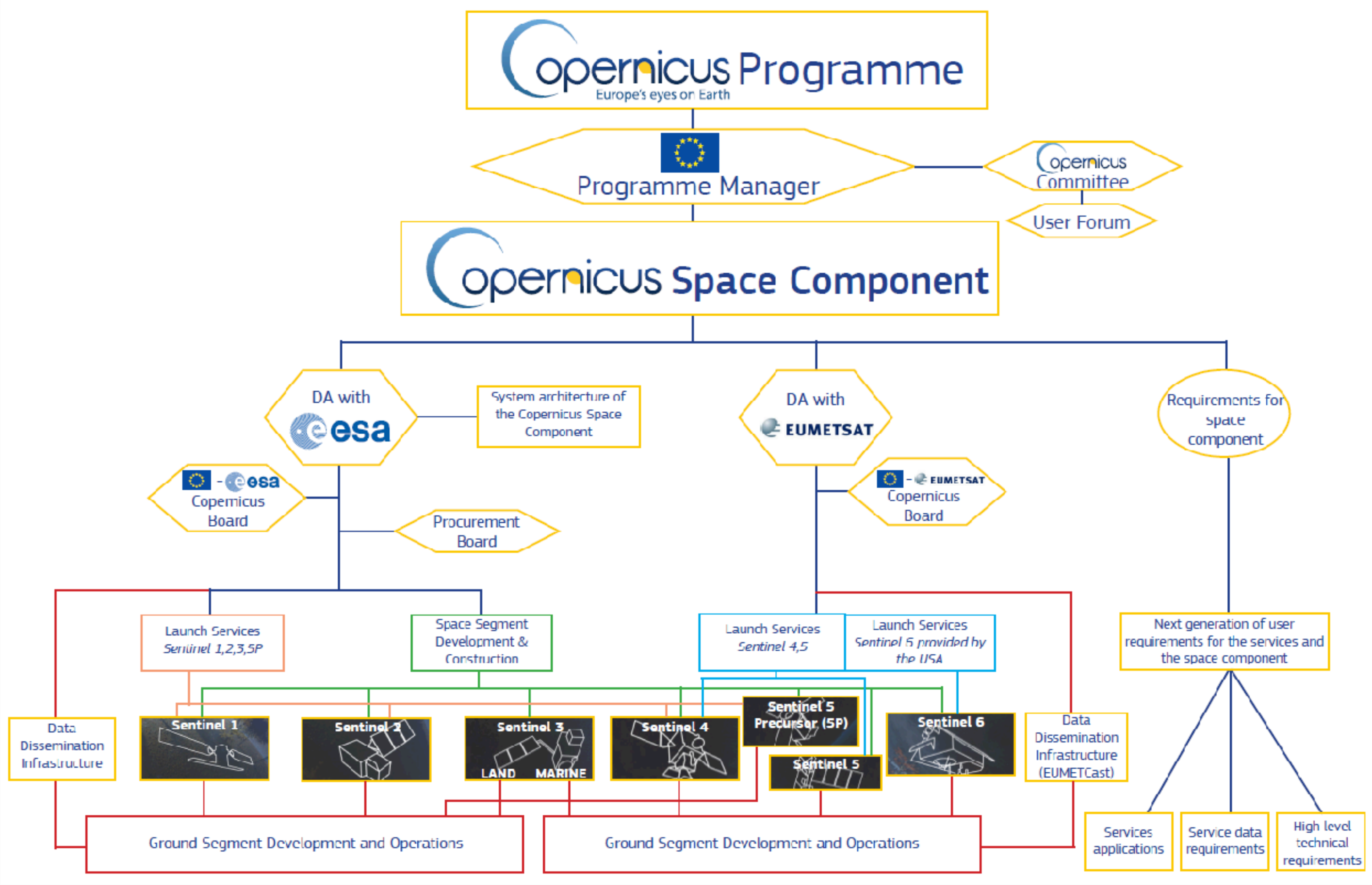
From infrastructure ...



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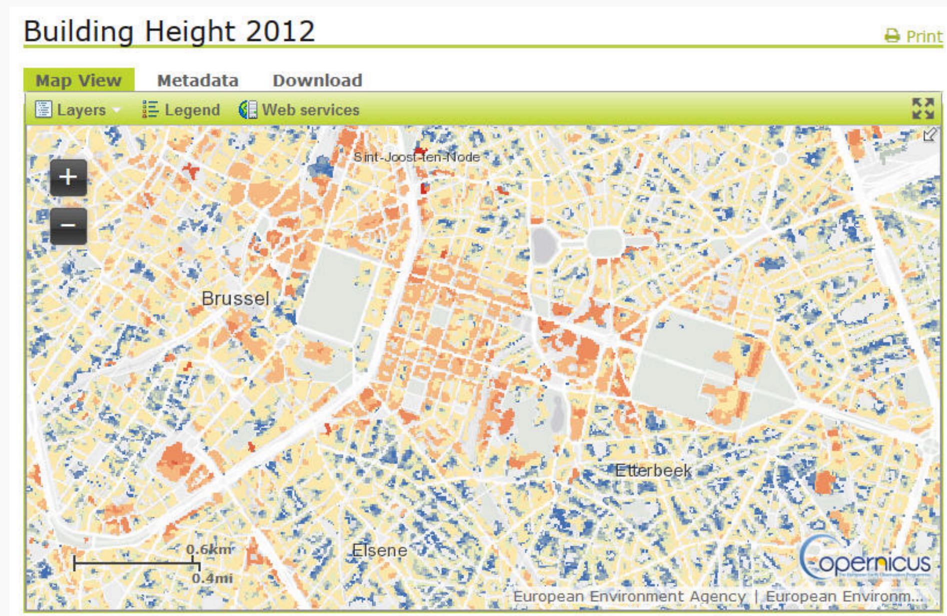
... to user services

- Usually in the form of applications ...
  - Presenting information derived from ‘raw’ data
- But also platforms ...
  - With tools, API’s ...



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Copernicus Benefits

- Economic, societal and environmental benefits
  - Estimating the monetary value of all the benefits for intermediate and end-users
  - To provide an idea on the potential ROI

- Evolving ecosystem around Copernicus information and data, including vibrant start-ups
- Full, free and open data policy
- Users doubled between 2014 and 2018 to 150.000
- Between 67 and 131 billion € benefits to European society (2017-2035)
- Yearly revenue for the space industry of about 1 billion €
- Around 4.000 skilled jobs created, annually

(PWC, 2017)

Need to improve skills to make this happen !

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The EO4GEO project

Towards an innovative strategy for skills development and capacity building in the space geo-information sector supporting Copernicus User Uptake

- **Duration:** 4 years from January the 1st, 2018
- **Budget:** 3,87 million €
- **Partnership:** 26 organisations + 22 (initially) Associated Partners (from 16 EU Countries) from Academia, Companies and networks
- **Addressed Areas:** Integrated Applications, Smart Cities, Climate Change

Co-funded by the Erasmus+ Programme of the European Union

The EO4GEO project

EO4GEO is a Erasmus+ Sector Skills Alliances for implementing a new strategic approach ("**Blueprint** ") to sectoral cooperation on skills (sectoral skills strategy)

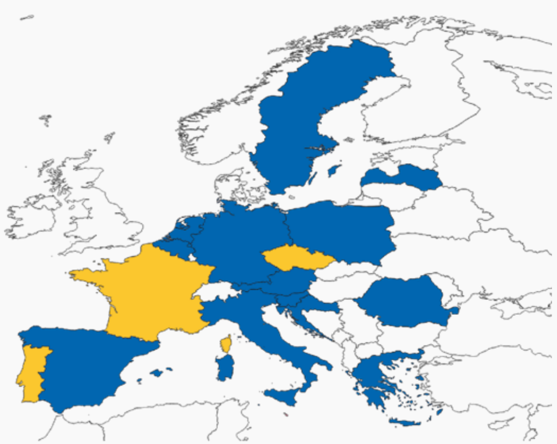
The Blueprint for Sectoral Cooperation on Skills was designed as part of the **New Skills Agenda for Europe** to offer a strategic response to sectoral skills needs

GISIG KU Leuven PLUS UJI GEOF UPAT FSU-EO

UT-ITC UNIBAS IGIK Planetek IGEA EPSIT

NOVOGIT GIB Spatial Services CLIMATE-KIC EARSC ROSA

UNEP-GRID NEREUS VITO CNR-IREA VRI IES ISPRA ALFA



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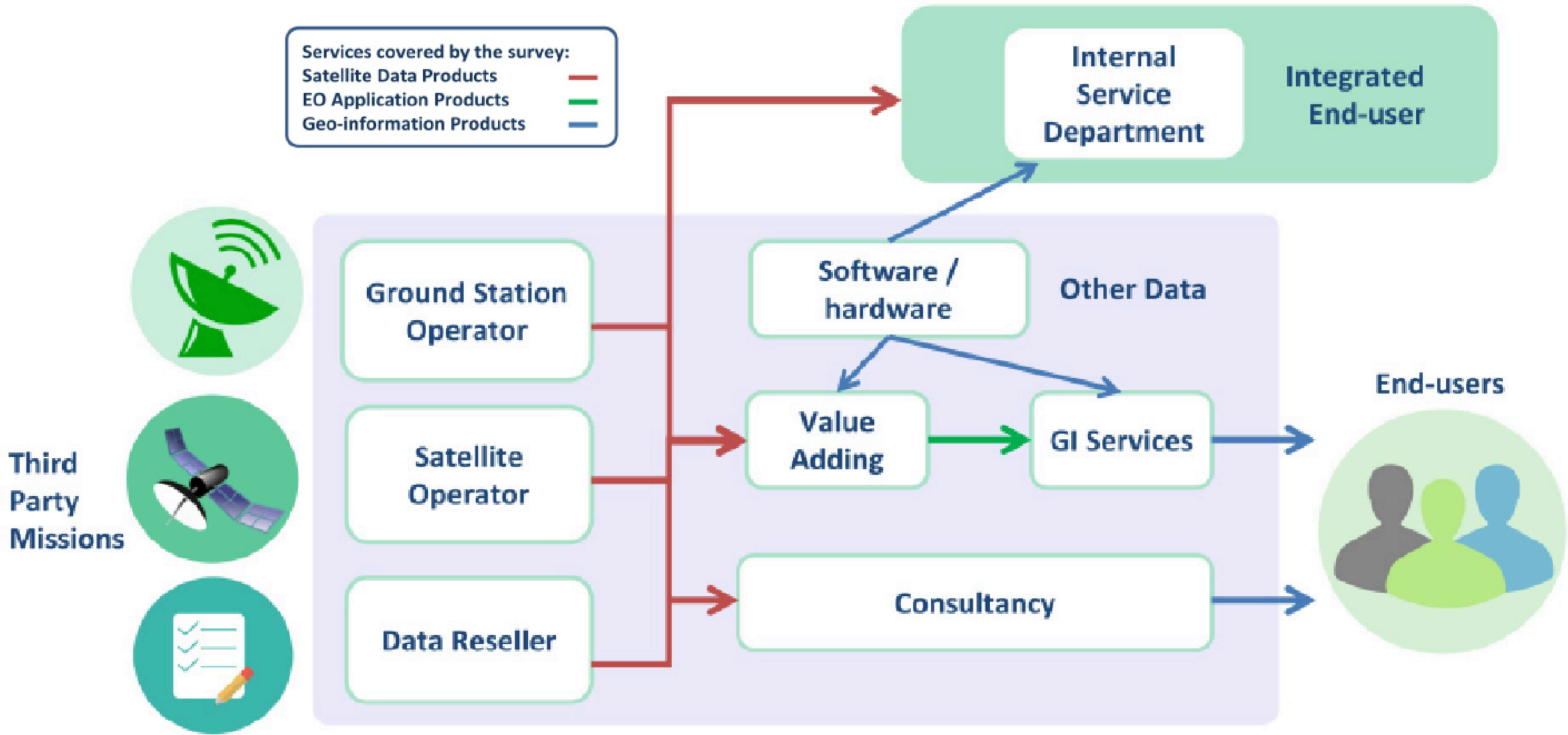
Current status

- Use of data in big organisations and limited service development for end-users

(EARSC, 2018)



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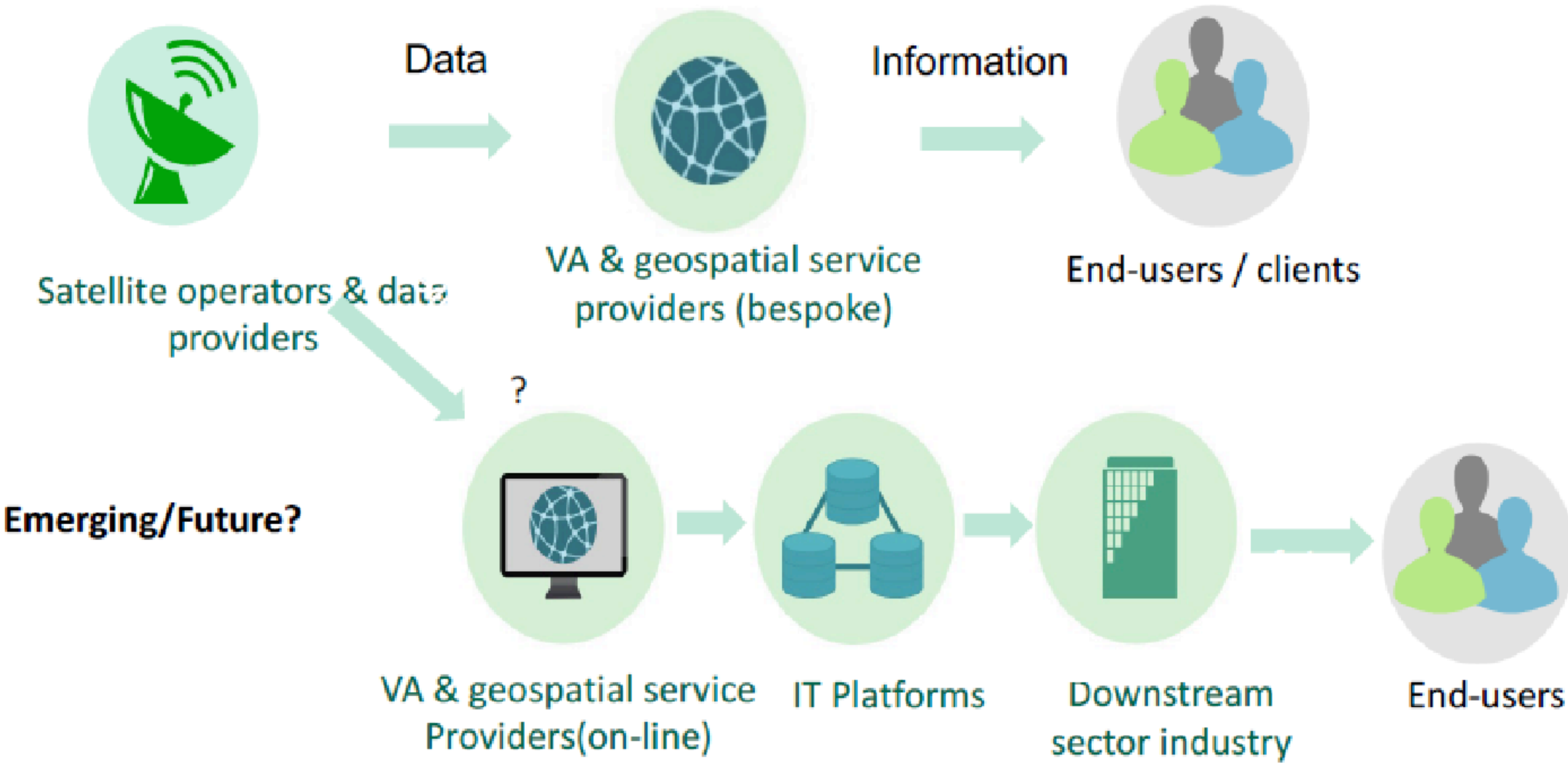
Future vision

- Central role for Value Added service providers and a dedicated downstream sector industry

(EARSC, 2018)



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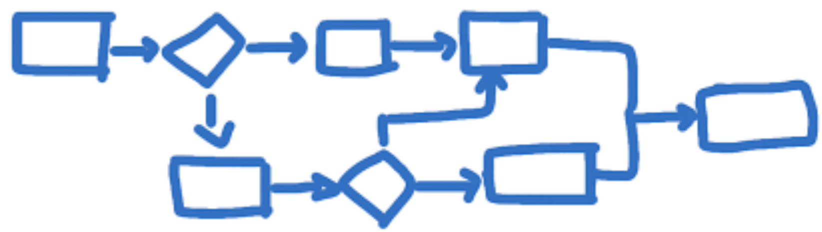
Work processes

- Need to understand individual scenarios or work processes
  - For which processes and activities (space/geospatial) data are used ?
  - Which are the actors performing these activities ?
  - How do they interact ?
  - How are the data and is the information flowing ?
  - ...

Quality of processes and their outcomes depend largely on actors having the **right skills**



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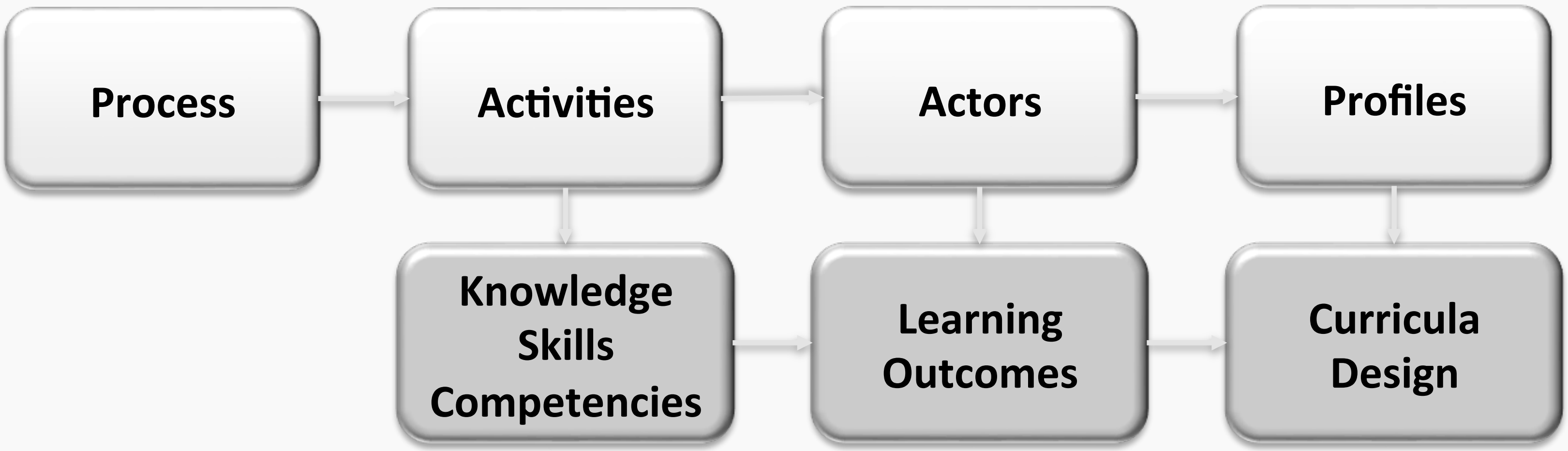
Work processes and curricula design

- EO4GEO will analyse processes for 3 areas
  - Climate change
  - Smart cities
  - Integrated applications (e-Government)
- Modelling particular scenario’s or work processes with BPMN
  - E.g. Monitoring air quality based on several parameters such as ozon



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Measuring impact

- Process performance – micro level
  - Ex ante and ex post measurements
  - Information collection
    - Through interviews with actors
    - Observations
    - Qualitative and/or quantitative
  - Ideal: embedding in the process
  - Estimates rather than 'hard' measurements
    - Categories

Time	Lead time	Flow time or throughput time
	Processing time	Actual efforts made
Costs	Fixed	Investment in education and training
	Variable	Permanent education and learning
Quality	Quality of the product	Data, figures, service, map …
	User satisfaction	Usability of the results

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Measuring impact

- Long-term impact – macro level
  - Analysing the uptake and AV
  - Information collection
    - Follow-up of students (Copernicus alumni)
    - Part of the Copernicus programme (EO4GEO Long-term Action Plan)
    - Qualitative and/or quantitative indicators
    - Cases and stories
  - Part of the QA and evaluation process of EO4GEO

New solutions developed
- Number of apps and services
- Number of end-users of these apps

Enlarged eco-system
- Number of new Copernicus users that followed training actions
- Number of companies and individuals that develop new apps
- New companies created

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Planned work in EO4GEO and beyond

- EO4GEO
  - Scenario's (work processes) will be chosen and modelling started (end of the year)
  - Stakeholders will be involved to collect information on performance (T1)
  - Training actions will be organised
  - Impacts of the training will be measured/documented (T2)
- Another project will be prepared
  - Focus on performance measurement framework, development and testing

Conclusion

- In order to have value added created in the Copernicus Value Chain the **skills development** should be taken into account
- Lacking the right skills (and not continuously updating them) will **impede user uptake** and **affect process performance**
- EO4GEO is experimenting with an innovative method for **designing curricula** and an approach to collect information about performance and impact

Thank you !

danny.vandenbroucke@kuleuven.be

www.eo4geo.eu

@EO4GEOtalks

Q & A for the Panel

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Final Remarks

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Socioeconomic Value of Data Webinar Series

Webinars are held from 12:30 - 1:30 PM ET.

Jun. 5: Does it matter? The Socioeconomic Value of Earth Science data, information, and applications

Aug. 7: The Information Pathway for Earth Science Data: Moving Between Supplier and User

Sep. 4: Measuring and assessing socioeconomic value

Oct. 2: The Value of Earth Science data for Agriculture and Climate Change Planning

Nov. 15 (tentative date): Managing disasters through improved data-driven decision-making

Dec. 4: TBD

Series is recorded and available on the ESIP YouTube Channel

Ways to stay involved

Webinar series

- Add your email to the sign-in sheet (goo.gl/ge1UyN)
- Follow the series on the ESIP YouTube channel

ESIP:

- Join the Monday Update
- Find active collaboration areas
- ESIP Winter Meeting in Bethesda, MD in January, 2019; See details at meetings.esipfed.org
- Check out one of our latest publications about the ESIP community:

  Virapongse, A., R.E. Duerr, E.C. Metcalf (2018). Knowledge Mobilization For Community Resilience: Perspectives From Data, Informatics, And Information Science. *Sustainability Science.*

Ways to stay involved

GeoValue:

- Join the GeoValue community! http://www.geovalue.org/
- Check out the GeoValue book:

  Kruse, J., J. Crompvoets, and F. Pearlman, editors (2017) GEOValue: The Socioeconomic Value of Geospatial Information. CRC Press/Taylor and Francis, Boca Raton, FL, USA.

Around the community:

- The Value of Information in Decision-Making, IEEE SSIT, November 13-14 2018 in Washington DC
- Extreme events, ecosystem resilience, and human well-being, ESA annual meeting from August 5-10, 2018 in New Orleans, Louisana.

Thank you!

For more information about the webinar and series, contact:

Arika Virapongse: av@middlepatheco.com