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

“Raw data”
- Space met data
  - Terrestrial met data
- Locations vulnerable people

Information products/services
- Meteorological Agencies
  - Forecasting
  - Weather products
  - Aggregate/Disseminate
- Municipalities
- Statistics Agency
  - Census data
- Utilities/Telecomms
  - Location of services
- Civil Protection Agencies
  - Emergencies data
  - Flood protection data
- River Managers
  - Dams & sluices data
  - River gauge data
- Remote Sensing Co.
  - Orthoimagery
- Insurance Cos.
  - Historic claims data

Aggregators
- Hydrological Consultant
  - Develop, flow and blue spot maps & hydrological adjustment layer
  - Engineering Co.
  - Develop, flood models & hydraulic simulations
- Environment Agency
  - Develop damage assessment maps

End users
- Preparedness
  - Municipalities
- Utilities
- Emergency responders
- Citizens
- Insurance Companies
- Realtors
- Media
- Construction/roads
- Environment Agency
  - Develop damage assessment maps
- NMA
  - Location of properties
  - Topographic data
  - Lidar data
  - Historic flood data
  - Compile DTM DSM
  - Create break lines
- Map flood obstacles, change data, mass balance, flood events

Note: coastal and marine not included

3D Geospatial Economic Value Quantification
# Ranked Benefits Schedule - Flood Management

<table>
<thead>
<tr>
<th>Ref</th>
<th>Actor</th>
<th>Process</th>
<th>Benefit</th>
<th>Score</th>
</tr>
</thead>
</table>
| 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:


GeoValue – Community of Practice
Website: www.geovalue.org

Book: The Socioeconomic Value of Geospatial Information
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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
• 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

- 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)

Choose a data retrieval option and select a state on the map
- State DroughtWatch,
- State map

<table>
<thead>
<tr>
<th>Explanation - Percentile classes</th>
<th>Low</th>
<th>&lt;=5</th>
<th>6-9</th>
<th>10-24</th>
<th>Insufficient data for a hydrologic region</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extreme hydrologic drought</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Severe hydrologic drought</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moderate hydrologic drought</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Below normal</td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
Forecasting Floods

Map of flood and high flow condition (United States)

Choose a data retrieval option and select a location on the map
- List of all stations in state
- State map
- Nearest stations

Explanation - Percentile classes
- 95-99
- >= 99
- River above flood stage
- Streamgage with flood stage
- Streamgage without flood stage
Infrastructure

Photo: USGS

Photo: DC Water

Photo: USGS

Photo: USGS
Water Quality

Photo: USGS

Photo: USGS

Photo: USGS

Photo: USGS
Navigation and Recreation
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

Identify Benefit Categories
(E.g., hazards, infrastructure)

Assess Benefit Outcomes
(E.g., lives saved, costs reduced)

Value (Monetize) Benefit Outcomes
(E.g., $ of statistical life, $ value of cost savings)
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
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

• 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$^3$

Regression Equations

• Relying on streamgages on similar stream segments with similar watershed characteristics

• Availability varies with availability of similar watershed

• Confidence varies with likeness of watershed

Onsite Streamgage Data

• Actual observations provides “best” (highest confidence) information

• Confidence in accuracy flow during different recurrence events varies with streamgage history length


“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:

\[ |(P^* \times M^*) - [(P_1 \times M_1) + (P_2 \times M_2) + (P_3 \times M_3)]| = \text{VOI} \]

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

• Right sized
  – Construction and installation costs will equal damages avoided

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

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

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

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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:

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Copernicus Value Chain

Improving the use of Earth Science data

Danny Vandenbroucke
Outline

• Context
• The Copernicus Value Chain
• Skills development
• Ongoing work
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)
... to user services

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

![User Services Diagram](image)
Context

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!
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
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
Current status

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

(EARSC, 2018)
Future vision

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

(EARSC, 2018)
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.
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
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

<table>
<thead>
<tr>
<th>Time</th>
<th>Lead time</th>
<th>Flow time or throughput time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Processing time</td>
<td>Actual efforts made</td>
</tr>
<tr>
<td>Costs</td>
<td>Fixed</td>
<td>Investment in education and training</td>
</tr>
<tr>
<td></td>
<td>Variable</td>
<td>Permanent education and learning</td>
</tr>
</tbody>
</table>
| Quality       | Quality of the product | Data, figures, service, map ...
|               | User satisfaction | Usability of the results |
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
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/documentated (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!

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www.eo4geo.eu

@EO4GEOtalks
Q & A for the Panel

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Final Remarks

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

August 7, 2018 | Webinar #2
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
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- Follow the series on the [ESIP YouTube](https://youtube.com) channel

**ESIP:**
- Join the [Monday Update](https://esipfed.org)
- Find active [collaboration areas](https://esipfed.org/collaboration)
- ESIP Winter Meeting in Bethesda, MD in January, 2019; See details at [meetings.esipfed.org](https://meetings.esipfed.org)
- Check out one of our latest publications about the ESIP community:
Ways to stay involved

GeoValue:

– Check out the GeoValue book:
  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](https://example.com), IEEE SSIT, November 13-14 2018 in Washington DC
– [Extreme events, ecosystem resilience, and human well-being](https://example.com), ESA
  annual meeting from August 5-10, 2018 in New Orleans, Louisana.
Thank you!

For more information about the webinar and series, contact:

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