Down to earth

Citation for published version (APA):

Kerstens, N. M. J. M., Giannopapa, C. G., Dolmans, S. A. M., & Reymen, I. M. M. J. (2017). Down to earth: popularisation of geo-information services in the Netherlands. *Space Policy*, 41, 12-19.
<https://doi.org/10.1016/j.spacepol.2017.04.001>

DOI:

[10.1016/j.spacepol.2017.04.001](https://doi.org/10.1016/j.spacepol.2017.04.001)

Document status and date:

Published: 01/08/2017

Document Version:

Accepted manuscript including changes made at the peer-review stage

Please check the document version of this publication:

- A submitted manuscript is the version of the article upon submission and before peer-review. There can be important differences between the submitted version and the official published version of record. People interested in the research are advised to contact the author for the final version of the publication, or visit the DOI to the publisher's website.
- The final author version and the galley proof are versions of the publication after peer review.
- The final published version features the final layout of the paper including the volume, issue and page numbers.

[Link to publication](#)

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal.

If the publication is distributed under the terms of Article 25fa of the Dutch Copyright Act, indicated by the "Taverne" license above, please follow below link for the End User Agreement:

www.tue.nl/taverne

Take down policy

If you believe that this document breaches copyright please contact us at:

openaccess@tue.nl

providing details and we will investigate your claim.

Down to earth:

Popularisation of geo-information services in the Netherlands

Nathalie Kerstens^a, Christina Giannopapa^b, Sharon Dolmans^a, Isabelle Reymen^a

^a Department Innovation, Technology Entrepreneurship & Marketing, Eindhoven University of Technology, 't Eeuwse 6, 5612 AZ Eindhoven, the Netherlands

^b European Space Agency (ESA), ESA HQ Mario-Nikis, 8-10 rue Mario-Niki, 75738 Paris Cedex 15, France

Abstract

The popularisation of geo-information services contributes to achieving Europe's 2020 goals to become a "smart, sustainable and inclusive growth economy" [1]. From a utilitarian perspective, this implies making the benefits of geo-information available to the largest number of users possible. To this end earth observation data has been made publicly available by various European earth observation initiatives for the use by industrial actors. However, the potential end-users frequently cannot readily utilize raw earth observation data in their business processes. Hence, to further stimulate the popularisation of geo-information services, a healthy value adding industry – that transforms raw earth observation data to geo-information services – is necessary. This involves the important, yet challenging, alignment between industry activities and government incentives. This paper discusses how a private cooperation of value adding companies in the Netherlands was established to contribute to the popularisation of geo-information services. Our case study shows how structural challenges can be overcome by forming a cooperation among value adding companies to gain the necessary capabilities to link downstream needs (market pull) with upstream availability (technology push). The results elaborate on policy actions for market stimulation, as well as developments within the value adding industry to strengthen and mature their market scope. As such, this study provides insight in how to strengthen the European value adding industry and promote the popularisation of geo-information services.

Keywords: earth observation data, geo-information services, cooperation, value adding industry, popularisation

1. Introduction and Background

Today's societal challenges, and those that will arise over the coming decades, require the space sector to focus on sustainable innovation and successful technology commercialization, a prime concern for most of the member states of the European Space Agency (ESA) and the European Union [2–4]. The commercialization of space technology through the development and spread of downstream geo-information services and applications offers many high-potential opportunities that contribute to achieve Europe's 2020 goals of becoming a "smart, sustainable and inclusive growth economy" [1]. Hence, the popularisation of geo information services, by making the benefits of geo-information available to the largest number of users possible, is a key way to generate economic and societal value

in the member states [5]. Here, the space sector can stimulate innovation, entrepreneurship and growth in other sectors – ultimately creating sustainable returns for society. In this respect, geo-information services also assists policymakers in developing, implementing and monitoring policies for sectors such as agriculture, environment, energy, transport, foreign, security and defence [6]. Given the many benefits of popularising geo-information services, a number of European earth observation programmes and initiatives have been initiated to generate earth observation data (and services) for public use, such as the European Copernicus programme, previously known as GMES (Global Monitoring for Environment and Security) [7]. These initiatives offer a variety of publicly available earth observation data as an open resource to generate opportunities for further service development [8]. More specifically, such programmes aim to stimulate a shift from upstream (space) technology push to downstream (market) pull regarding services and applications based on earth observation data. Since the development of the space sector is supported by public funds, stimulating this "downstream" economic and societal impact of space technology is a priority for policymakers. However, the European downstream industry faces several structural challenges in popularizing the use of earth observation data to unleash its potential [9].

A key challenge is the guaranteed availability of satellite data, since availability is not (yet) continuous over long time frames. Other significant challenges include general unawareness of satellite data possibilities, market segmentation and a lack of coordination between national and EU level initiatives. Moreover, the companies active in this relatively new industry of transforming earth observation data into commercial services are often start-ups or small university spin offs. Due to the liability of newness [10] these companies typically face various challenges to gain impact in a new technology market, for example due to a lack of (financial) resources, difficulty to attract skilled employees and inability to compete with well-established firms [11,12]. Across Europe, various solutions have been coined to overcome these issues, however policymakers' main focus typically remains on developing a data infrastructure - rather than aiming at downstream or end-user needs. Although the space industry is shifting from a technology push to a market pull orientation, the approach for commercializing satellite data largely remains a push strategy [13,14].

Most European member states have focused on developing a national infrastructure to provide easy public access to the earth observation data generated in the various programmes. Yet, merely providing access to earth observation data is not the only hurdle in stimulating new markets and information services based on this data [14]. This also became apparent in the Netherlands. In 2012, the Dutch government and the Netherlands Space Office (NSO) made satellite data for the Dutch territory freely available to the Dutch market actors in order to stimulate market development for geo-information services. Yet soon after the start of this initiative, it became clear that simply providing access to free data proved inadequate to successful commercialization on a large scale. Potential end-users are often not aware of the opportunities of earth observation data. In particular, it is hard to stimulate the use of earth observation data, since these foreseen end-users of the data (i.e. market actors such as energy companies) cannot readily utilize raw geo-data – instead they require *information*. Hence, earth observation data needs to be tailored or transformed to specific applications or services before market actors can and will use it. How to overcome these challenges?

In the Netherlands, a unique solution surfaced in the form of an open cooperation among Dutch data transformation companies, or value adders, hereafter NEtherlands Value Adding Services Companies (NEVASCO). In addition to networking and collective public lobby activity by cooperation forms such as the European Association of Remote Sensing Companies (EARSC), NEVASCO also actively integrates the technological capabilities of its members to offer jointly developed geo-information services for areas such as energy, smart cities, agriculture and civil and military security [15]. In the value chain for commercializing earth observation data, value adders are a critical link in connecting upstream satellite data technologies and downstream end-users. This study gives insight in how the NEVASCO cooperation was formed to gain the necessary capabilities and momentum to overcome structural challenges in the popularisation of geo-information services.

The remainder of this paper is structured as follows: first, we introduce our method. Next, challenges for earth observation data commercialization in the European market are outlined. Subsequently, the paper elaborates on the historical developments for earth observation data market stimulation in the Netherlands, as well as the formation of the cooperation NEVASCO as a mechanism to overcome these encountered challenges. The paper ends with a discussion providing policy makers and industry actors with key insights that enable the formation of a cooperation to link downstream user needs (market pull) with upstream technological possibilities (technology push) [6,16]. The ability to link market needs with available technology ultimately maximises the potential benefits of current and future space technology developments.

2. Method

To better understand the various structural challenges to the popularisation of geo-information services and how to overcome them, this study first draws on a systematic analysis of archival data to extract structural challenges. Secondly, we conduct a qualitative in-depth case study [17] of a private cooperation of value adding companies in the Netherlands, to uncover how such a cooperation can overcome various structural challenges.

2.1 Data collection

The collected data for this study consists of first archival documents, secondly semi-structured interviews and thirdly participant observation. Table 1 provides an overview of the collected data sources and how they contributed to our analysis.

Archival documents collected consist of policy documents, reports, websites and presentations by NSO and NEVASCO on their operations. Documents were selected based on their relevance for gaining insight in the developments of the Dutch and European value adding industry and market for earth observation data in general. They were retrieved from the websites of Copernicus, EARSC, NSO, NEVASCO, the Dutch government and relevant policy documents were provided by NSO. Semi-structured interviews were held with the founder of NEVASCO, three representatives of NSO and directors, entrepreneurs and a business developer from five of the initially involved value adding companies in the foundation of NEVASCO. Table 2 provides a detailed overview of the interviewees, their companies (which have been anonymized for confidentiality reasons), their experience and

relevance to NEVASCO and the amount and date of interviews held with them. In a total of fifteen interviews, interviewees were asked to elaborate on the activities their organisations perform, the Dutch value adding industry in general, the challenges and opportunities they encountered in commercializing satellite data, their roles in the foundation of the cooperation NEVASCO and how they perceive the role of NEVASCO. The interview data is triangulated with additional sources of data, including participant observation during workshops held at NSO, secondary data on the European earth observation market, organisational documents of NEVASCO and presentations by NSO and NEVASCO.

Data sources	Insight given by the data
<i>Archival Data</i>	
<i>Policy documents, reports, websites & presentations</i>	
18 study reports on geo-information services (retrieved from http://www.copernicus.eu/library/detail/252 , accessed on 9/1/2017) and 7 reports on the downstream sector (retrieved from http://earsc.org/library/ , accessed on 9/1/2017) (2013-2016)	Structure of the European downstream sector for geo-information services
12 policy documents and 11 downstream roadmaps - provided by NSO (1981 – 2016)	Dutch policy developments & commercial market opportunities for geo-information services
2 reports on NEVASCO (2014 – 2015)	Operational development of NEVASCO
Annual report of the Holland Space Cluster 2015 (retrieved from http://www.hollandspacecluster.nl/Documenten.html , accessed on 9/1/2017) (2015)	Developments in the Dutch national space sector in terms of collaboration between government, knowledge institutes and private parties
Study report on the Dutch value adding industry (retrieved from https://www.rijksoverheid.nl/documenten/beleidsnota-s/2014/09/11/de-ruimte-voor-het-gebruik-meer-waarde-voor-onze-aarde , accessed on 9/1/2017) (2014)	Needs of the Dutch value adding industry, market potential for geo-information services
Letter from the Dutch Minister of Economic Affairs (retrieved from https://www.rijksoverheid.nl/documenten/kamerstukken/2014/09/11/kamerbrief-nota-over-ruimtevaartbeleid-2014-2020 , accessed on 23/12/2016) (2014)	Development of Dutch policy for earth observation
Report Small Business Innovation Research (SBIR) space projects provided by NSO (2016)	Evaluation of the SBIR projects in the Netherlands
Report on earth observation from the Hague centre for Strategic studies (2016)	Market developments for earth observation in the Netherlands
4 Euroconsult Government Space Affairs reports (2013)	European market for geo-information services
NSO & NEVASCO news articles (retrieved from www.spaceoffice.nl & www.nevasco-group.nl , accessed on 23/12/2016) and websites of the Dutch value adding companies (accessed on 23/12/2016) (2014-2016)	Public promotion of NEVASCO
PowerPoint presentations given by NEVASCO and NSO at a variety of events (2015 - 2016)	Promotion of NEVASCO
<i>Interview & Observation Data</i>	
15 transcribed interviews (45-90min each; 193 pages of transcripts) (September 2015 – December 2016)	Challenges, opportunities, relevant actors and activities in the formation of NEVASCO & the impact of NEVASCO
Earth Observation Science & Society Symposium (2015)	Collaboration of science, industry and government in the Netherlands to

Symposium Big Data Technologies for Earth Observation (2015)	benefit market development Integrated technologies for various data sources
Downstream Roadmap Workshop (2016)	Development of downstream roadmaps
Space Network Meetings (2016)	National space policy and trends in commercial space
Formal and informal discussions at NSO (2015-2016)	National policy for geo-information services and the Dutch value adding industry

Table 1 Data sources

Organisation	Interviewee	Experience and relevance to NEVASCO	Number of interviews	Date of the interviews
NSO	Advisor for Operational Usage	<ul style="list-style-type: none"> Expert in scientific possibilities of earth observation applications Involved in the evaluation of SBIR projects Member of the European Copernicus committee to coordinate efforts of NSO to realise participation of Dutch industry in this programme Translating Dutch industry needs towards ESA and EU 	3	9/9/2015 13/11/2015 11/2/2016
	Senior Advisor for Science and Satellite Data Usage	<ul style="list-style-type: none"> Link scientists specialised in upstream technologies with development of downstream services Stimulation of downstream activities Representative of NSO in the formation of NEVASCO 	2	15/10/2015 18/8/2016
	Senior Policy Advisor	<ul style="list-style-type: none"> Longitudinal involvement with the development of the Dutch policy on earth observation stimulation Strong focus on stimulating the use of satellite data to create societal benefits 	1	29/11/2016
NEVASCO	Founder of NEVASCO	<ul style="list-style-type: none"> Serial entrepreneur, managing director of a value adding company in maritime consultancy, one of the EARSC directors and member of the board of Holland Space Cluster 	2	30/10/2015 15/8/2016
MarCo	Entrepreneur	<ul style="list-style-type: none"> Independent advisor in the value adding industry and specialized in the marketing for earth observation data services and involvement in the establishment of NEVASCO 	2	1/12/2015 24/8/2016
ConsuCo	Entrepreneur	<ul style="list-style-type: none"> Owner of a consulting company for other value adders to enable them to enlarge their market share and gain more potential customers for their services ConsuCo is one of the founding members of 	1	1/12/2015

NEVASCO				
DeformCo	Business Developer	<ul style="list-style-type: none"> • Business developer at DeformCo, at the sharp end of getting new users for the products they develop for soil deformation • DeformCo is one of the founding members of NEVASCO 	1	27/11/2015
PipeCo	Director	<ul style="list-style-type: none"> • Director of PipeCo, which is a company that measures movements of piping infrastructure • PipeCo is one of the founding members of NEVASCO 	1	30/11/2015
OffshoreCo	Director	<ul style="list-style-type: none"> • Director of OffshoreCo, which is a company that solves environmental issues in the offshore industry • OffshoreCo is one of the founding members of NEVASCO 	1	14/12/2016
WaterCo	Director	<ul style="list-style-type: none"> • Board member of NEVASCO and director of WaterCo, which is a company that focusses on sustainable food provision • WaterCo is one of the founding members of NEVASCO 	1	21/9/2016

Table 2 Interviewees¹

2.2 Data analysis

The first part of the analysis consisted of the identification of problematic issues in the popularisation of geo-information services in Europe in the collected archival data (see Table 1) and literature. These problematic issues were listed and grouped into challenges relevant for the macro-environment of the value adding industry. The challenges were categorized according to political, socio-economic and technological concerns [18]. The second part consists of an in-depth case study that investigates how the formation of a cooperation of value adding companies can help to overcome these various challenges. To understand the Dutch context of the cooperation, the archival data (see Table 1) and literature was analysed to outline the history of the Netherlands in the efforts to stimulate the development of services based on earth observation data. Special attention was given to the formation of NEVASCO. The resulting historical overview was validated with the Senior Policy Advisor from NSO. Subsequently, the interview transcripts were coded for actions taken by NEVASCO to overcome the European challenges in the market for geo-information services. All actions related to the political, socio-economic and technological domains were grouped and studied in more detail.

3. Results

The next section presents an overview of challenges in the popularisation of geo-information services in Europe. Subsequently, we zoom in on the Netherlands and provide an overview of the historical developments of popularising geo-information services in the Netherlands, to provide context for our case study. Finally, we present how the NEVASCO cooperation was formed and how it allows

¹ Transcripts are available upon request by contacting the corresponding author (n.m.j.m.kerstens@tue.nl)

member companies to deal with these challenges in order to further enhance popularisation of geo-information services.

3.1 Challenges in the popularisation of geo-information services in Europe

In order to have a structured overview of the difficulties that the value adding industry in Europe faces in the popularisation of geo-information services, the most important challenges are listed in Table 3 below. Our analysis points to political, socio-economic and technological issues, which have been categorized to better understand the multidimensional nature of these challenges [18]. *Political* challenges relate to the role of the political climate in downstream service development, such as the absence of a governmental investment- and R&D agenda for satellite data services [19]. The acceptance of geo-information services by the general public is a key *socio-economic* challenge. In particular, it is considered challenging to make the benefits of geo-information services known and visible to a large amount of potential users, even more so because such services are typically perceived to be costly [6][9]. From a *technological* perspective, a prime challenge is the technical uncertainty regarding the continued availability of satellite data, as it inhibits final users to deploy such data in their business processes [9,20].

As Table 3 shows, the field of geo-information services is quite complex. Hence, making the benefits of geo-information available to a larger number of users thus requires an approach capable of dealing with the multidimensional nature of the challenges faced in this field.

Domain	Challenges
Political	<ul style="list-style-type: none"> • Inadequate involvement of user needs in the development of downstream services [9] • Absence of a governmental investment- and R&D agenda for satellite data services [19] • Lack of coordination between upstream and downstream market development [9] • Since the value adding industry is fragmented, it faces lobby challenges for future policy development for satellite data services [19] • Lack of coordination between stakeholders in the Dutch value adding chain from earth observation data towards information incorporated in the processes of final users [20] • Insufficient alignment of ambitions and initiatives on national and international level for satellite data service development [8] • Poor legislation and policy interactions to react to market opportunities for geo-information services can hinder market development [20] • Governmental stimulation can cause market distortion, since the competition in the value adding industry is hard and governmental support could lead to inequalities [19] • Insufficient open data policies and mechanism to make publicly funded data available to a wider user community [20]
Socio-Economic	<ul style="list-style-type: none"> • The value adding industry traditionally relies on government-funded projects, constraining proactive market exploration[20] • High market segmentation inhibits focal market development [19] • The possibilities of earth observation data and forthcoming geo-information services are not known by the wider public, challenging the value adding industry to market their services [9] • Geo-information services are perceived to be costly and difficult to integrate in business processes of final users [20] • Small companies in the value adding sector typically lack entrepreneurial skills to expand

	<p>their markets [9]</p> <ul style="list-style-type: none"> • The value adding industry consists mainly out of small parties that alone cannot bear financial and legal risks for contracts with large parties [21] • The rules, regulations and capacity for participation in large international tenders make it hard for small value adding companies to participate [20] • A lack of lead users for geo-information services impedes maturation of geo-information services for the larger market [9]
Technological	<ul style="list-style-type: none"> • Technical uncertainty about the continued availability of the satellite data inhibits final users to deploy it in their business processes [9,20] • Competition of other services and data sources and well established technologies hinder end users to shift to the use of satellite data [8] • The possibilities and benefits of satellite data are difficult to assess for end users, causing satellite data to be integrated less frequent in end user business processes [9] • Data transformation is necessary to transform raw satellite data into useful information for end users, which is mostly not part of the core business of the end users [9]

Table 3 Challenges in the popularisation of geo-information services in Europe

3.2 Popularisation of geo-information services in the Netherlands, a historical overview

To understand how the Netherlands has served as a catalyst for the formation of a private cooperation of data transformation companies, Table 4 provides an overview of key historical developments that have stimulated the use of geo-information services in the Netherlands. Historically, the Netherlands has shown great interest in the generation of these services and related products. Ranging from the development of topographic maps based on aerial photography in the early twenties, to the current Small Business Innovation Research projects where government agencies act as lead-users of geo-information services. The past century, the government has structurally allocated funds to build a solid knowledge base for the development of these services.

More recently, NSO has been established to make the benefits of geo-information available to the largest number of users possible by providing fertile ground for the development of value adding companies. NSO aims to stimulate demand driven activity, or market pull, such that value adding companies and their customers ultimately inspire the development of new space instruments that will deliver earth observation data that responds to market needs. As Table 4 illustrates, various events have actively contributed to the early development of the Dutch value adding industry.

Timing	Development
1921	Establishment of the Photo-Technical Cartographic Service (FCB), afterwards KLM Aerocarto, to take aerial panoramas of the Netherlands
1930's	Establishment of the Meetkundige Dienst (Geometrical Service) as the knowledge centre on innovative developments in remote sensing
1950	Founding of the International Training Centre for Aerial Survey (ITC) by Willem Schermerhorn to share the Dutch knowledge in aerial topographic mapping and educate developing countries in the use of these techniques
1966	Establishment of the Interdepartmental Committee for space research and –technology (ICR) to prepare Dutch space policy
1970's	Establishment of the Application Research for Remote Sensing Techniques (NIWARS) programme, leading to the first remote sensing research programmes for civilian applications
1978	Foundation of the Policy Committee Remote Sensing (BCRS) by seven governmental departments

	to support remote sensing projects based on aerial photography
1980's	Development of national policy for the support and development of the first ESA remote sensing satellite ERS-1
1986-1991	Foundation of the National Remote Sensing Programme 1 & 2 (NRSP) to support the development of applications based on remote sensing techniques (budget of approximately 30 million euros)
1992-present	Additional earth observation policy with the user support programmes (GO) to support Dutch researchers to use scientific instruments from space for high quality earth observation research
2000	Establishment of the Geomatics Business Park, a business and science park to stimulate entrepreneurship in the development of geo-information services
2003	Development of a National User Platform for Earth Observation (NGPA) to enhance communication between the (scientific, governmental and commercial) users, knowledge institutes and industry and to provide advice on usage of geo-information services to support policy development
2008	Dutch notion on the Global Monitoring for Environment and Security (GMES) on how to support the priorities of the Netherlands in this programme
2008	The Ministry of Economic Affairs, Ministry of Education, Culture and Science, Ministry of Transport, Public Works and Water Management and the Netherlands Organization for Scientific Research (NWO) signed an agreement for the establishment of NSO as executive body of the Dutch space policy. The role of NSO is to develop and execute the Netherlands' space programme and serve as a central point of contact for the national and international space community
2012	National Satellite Data Portal is established by NSO to provide the Dutch market with free satellite data for the Dutch territory to prepare for the Copernicus free data stream. In addition, it stimulates research and offers a test ground for the global market.
2011	Development of the High-tech Systems & Materials (HTSM) Top sector Policy Roadmap Space 2015-2020 with one axe R&D in the Netherlands in terms of space applications with themes such as data access, -storing and -processing [22]
2012-present	NSO initiates the development of the downstream industry roadmaps to determine strategic focal areas for the Netherlands to further develop services based on earth observation data
2014-present	NSO manages the Geodata for Agriculture and Water (G4AW) programme, commissioned by the Ministry of Foreign Affairs to stimulate the use of geo-information in order to improve food security and economic development in 15 developing partner countries [23]
2014-present	NSO organises Small Business Innovation Research (SBIR) projects in which value adding companies develop geo-information services for governmental actors that serve as lead customers
2016	Official foundation of the cooperation NEVASCO in January 2016

Table 4 Key historical developments in the Netherlands [24]

3.3 Formation of the NEVASCO cooperation

The various developments as outlined in the previous section show that historically the Netherlands has recognized the importance of developing user segments for the earth observation infrastructure. Especially during the past years the activities from NSO, such as the development of the downstream roadmaps, the foundation of the satellite data portal and the SBIR projects stimulate companies in the value adding industry to develop geo-information services according to the needs of end-users. The value adding industry has been characterized by a fragmentation of relatively small companies, mostly rooted in space industry and formed as university spinoffs. These companies all have their own (technical) expertise, based on specific types of satellite data and algorithms to process this data. Yet, individually, these companies cannot offer a large variety of services and products. Moreover, because of their small size, they lack the necessary resources and momentum to grow. In response, many of the value adding organisations have chosen to become part of the NEVASCO cooperation.

NEVASCO is a private initiative and is established as an open cooperation among Dutch value adding companies to provide geo-information services for areas such as energy, smart cities, agriculture and civil and military security [15].

NEVASCO was officially established in 2016 to facilitate the operations of Dutch value adding companies on the international market. The cooperation is based on the idea of NEDECO (Netherlands Engineering Consultants), which, since 1951 has acquired large international infrastructural projects for collaboration between Dutch engineering. By establishing NEVASCO, the value adding companies were collectively able to overcome several of the challenges indicated in Table 3, as explained in the next section. And by making the (benefits of) earth observation data more widely available, the cooperation contributes to the popularisation of geo-information services.

3.4 Overcoming challenges in the popularisation of geo-information services in Europe

This section shows how (the formation of) the cooperation NEVASCO allowed member companies to overcome political, socio-economic and technological challenges as outlined in Table 3 in the previous section.

3.4.1 Political Challenges

There are various political challenges that hinder the popularisation of geo-information services on a large scale (Table 3). One of the main issues is the general European (policy) mind-set, which on average still largely adheres to a technology push perspective. This focus on upstream (technology) development results in services that are predominantly based on technological possibilities rather than their relevance for potential users, as concluded in a study report on the Dutch value adding industry from 2014 [21]. By not originating from specific user requirements, these geo-information services are often not economically viable in commercial downstream markets. Before 2012, most of the governmental funding in the Netherlands was allocated to upstream technology developments. Although it is important to allocate funding to downstream development, the coordination between future upstream and downstream developments might be even more important, as announced on the NSO website in June 2015 [25]. To generate societal returns on government investments, both funding and research for technology and service development should go hand in hand. Hence, connecting the downstream (value adding) industry to the upstream developments would result in upstream developments towards generating data that will benefit as many users in society as possible [26]. The founder of NEVASCO explains: *“We are dependent on the organisations that built the satellites and we should make sure that the right space infrastructure can be developed based on the information our customers need.”* [27].

The upstream funding programmes form the basis for the development of scientific instruments that generate signals and forthcoming data, for which no potential market is defined yet or for which the development of commercial services is currently too costly. Therefore, in 2012, the founder of NEVASCO interacted with the Ministry of Economic affairs to raise awareness for the importance of a national downstream programme, as explained by the Senior Advisor for Science and Satellite Data Usage from NSO: *“I think that the founder of NEVASCO started those negotiations with the Ministry of*

Economic Affairs in 2012, because no real specific downstream policy existed yet. There was no money for downstream activities and if there was, there was no programme. So there was no plan on how to allocate that money.” [28].

The negotiations of the founder of NEVASCO and the vision of NSO regarding integrated downstream policy inspired the Ministry of Economic Affairs to develop downstream policy for the Dutch value adding industry, as shown in a letter to the Dutch House of Representatives from the Minister of Economic Affairs in 2014 [29]. In that year, a task force was set up by the Ministry of Economic Affairs to provide an overview of the needs of the value adding industry (in a study report on the Dutch value adding sector [21]) and supported the development of Dutch space policy for 2014-2020. Before the formation of NEVASCO, the Dutch value adding industry was not collectively organized, inhibiting the development of integrated policy towards the future development of the value adding industry. The founder of NEVASCO illustrates: *“Everyone had their own vision, their own voice and everyone tried to influence policy makers in their own way. Figuratively speaking it is like you have one hundred frogs in a wheelbarrow and they all jump in another direction, which poses a big problem for moving forward. In this way, policy makers see the value adding sector as unorganized and as a sector that does not know where to go. I used that to convince the sector that we need to develop a cooperation form to influence policy makers.” [30].*

Hence, by collaborating, Dutch value adding companies could jointly develop a vision increasing their influence towards the national government. This in turn would create opportunities to align national ambitions and initiatives with downstream activities by the value adding industry to further stimulate the development and use of geo-information services. Based on both economic and political incentives, the idea of collaboration among the Dutch value adding companies was born. The founder of NEVASCO worked hard to join forces among the relevant parties to gain support. Collaboration started via the informal organisation of the value adding industry under the lead of the founder of NEVASCO, as the Senior Advisor for Science and Satellite Data Usage from NSO explains: *“The founder of NEVASCO had conversations, not only with the Ministry of Economic affairs, but also with the companies. He actively approached all possible value adding companies you can imagine. He did this all on his own and that was really important to establish the connection within the value adding industry. This was done to make people realize that they all have the same goal, so that they want to collaborate.” [28].*

NEVASCO was officially established in January 2016. This cooperation with a clear goal and vision gives the Dutch value adding industry one face and serves as a central point of contact for other public and private parties, as announced in a presentation of NEVASCO from December 2015 [31]. If industry goals are aligned with national policy goals, it becomes more easy to allocate funding, as the Advisor for Operational Usage from NSO explains: *“We urge other companies to enter NEVASCO as well, which would make it much more effective to direct possible government support aimed at stimulation of the use of space data.” [32].*

Another critical issue hindering the development of geo-information services is the coordination of the various stakeholders in the Dutch value adding chain. As the value chain consists of many different stakeholders involved in transformation process from earth observation data towards information incorporated in the process of final users, such coordination between various public

agencies and industrial actors is challenging. Here, NEVASCO serves as an efficient intermediary between NSO, the value adding companies and the end-users of earth observation data.

3.4.2 Socio-economic challenges

There are various socio-economic challenges in making geo-information services available to of end-users (Table 3). Traditionally, the value adding industry relies on government-funded projects for the development of new products and services. These products and services are typically based on the available technological (data) possibilities, whereas target users or markets are identified at a later stage. However, these projects usually do not include any financial resources to find and address a target market for the developed services or to stimulate operational usage on a larger scales, as announced in a presentation of NEVASCO from December 2015 [31]. The Senior Policy Advisor of NSO indicates: *"You see that they [the small value adding companies] all emerged from a knowledge institute. They see a niche market and think "I am going to start for myself" and then manage to build this [a company] up with a lot of project funding and [only] later search for customers, but lack sufficient financial means to really invest in a production chain."* [33].

This illustrates how the market for earth observation data has become highly segmented, as concluded in a study report from 2016 published by the Hague Centre for Strategic Studies [19]. Although the possibilities for earth observation data are endless, these developments make it hard to define key market segments. In particular, it makes it difficult for the general public to recognize the potential that earth observation data and forthcoming geo-information services have to offer. To overcome this challenge, NEVASCO has identified four key market segments, as announced on their website [15]. Such clearly defined segments allow NEVASCO to conduct targeted market research and determine which products and services are most promising and viable according to the expertise of its member companies. The founder of NEVASCO explains: *"We are active in four markets and for each market I have a market coordinator... I let them start with describing what they know and then I share this with the whole sector by saying how the market works, how large it is, in which geographical areas it lies and what the information needs are. The next step is to think of what services we could deliver to that type of customers in those market segments as a collective, not as individual companies."* [30].

In addition it is important to demonstrate the possibilities of the data to potential users. Currently, geo-information services are perceived to be costly and difficult to integrate. Moreover, the many different applications of earth observation data are often invisible to potential users. A catalogue of available services offered by NEVASCO members might prove helpful to engage users, as published in an article from 2015 in the magazine from the Ministry of Security and Justice [34]. The founder of NEVASCO explains: *"Sector wide we are developing an action plan to ensure that individual companies can offer their products and services in a certain format. Soon there will be an online catalogue available with products and services we can offer directly to large customers in a target area. We are very consciously trying to bring the knowledge and products of the individual companies together under the heading of NEVASCO."* [27].

Economic impact plays an important role in convincing the value adding organisations to collaborate. It is quite difficult for the small value adding companies to gain large multinationals as customers for their services, as for example indicated on the website of NSO in April 2015 [35].

In this respect it is also difficult for the fragmented value adding industry to participate in large international tenders for the development of downstream applications. Such tenders typically require substantial investments and various disciplines, and small value adding companies often lack these means to participate. The formation of NEVASCO also facilitates such participation as the business developer of DeformCO explains: *“We think that for large tenders for which you need multiple downstream disciplines it [NEVASCO] can be very useful. We do not like tenders... If NEVASCO can build the capacity for this, we will be more than happy to contribute.”* [36].

By joining the expertise of the different value adding companies, more potential services, applications and combination of services are known to better serve the need of the final users, as the director of PipeCo explains: *“For this matter [gaining potential customers] you can work together in something like NEVASCO. This helps.”* [37].

3.4.3 Technological challenges

The technology proves to be challenging to implement on a larger scale (Table 3). In developing geo-information services, various data transformation steps are necessary to tailor earth observation data to the information needs of end customers or users. Typically, each small value adding company has expertise in a particular data transformation algorithm. However, the market increasingly demands more complex and integrated solutions, as the founder of NEVASCO explains: *“The market says they want a product for safe offshore operations. They do not only want wind velocity, but wind, waves, currency, depth, ice, etc. So they want a lot more things, not just that one product, and they want it continuously. So, [start developing] what we call turnkey [complete] products.”* [30].

To overcome this challenge, NEVASCO brings together the expertise of multiple companies to offer more complex products and services. Hence, one of the main advantages for individual companies to work together under the heading of NEVASCO is to be able to deliver integrated products and services, as concluded in a study report on NEVASCO from 2015 [38]. The director of WaterCo emphasises: *“NEVASCO can help by delivering a more integral offering abroad ... NEVASCO can solve more complex issues for which customers need a diversified offering.”* [39].

Another technological challenge in popularising geo-information services concerns the broad range of earth observation data, especially in combination with other types of information. There is a vast amount of data available in various formats and it is generated at varying speeds. Therefore it is difficult for potential users to distinguish between these various types of data and to assess what data is best suited to implement in their business processes. Moreover, this data is generated by many different sources, making it hard for users to assess whether it is accurate and up to date. Since many potential users will only invest in geo-information services, if the data is reliable, accurate and up to date, NEVASCO decided to jointly work on data certification for processed earth observation data, as described in the study report of The Hague Centre for Strategic Studies from 2016 [19] and as explained by NEVASCO’s founder: *“If you receive a certificate, the customer knows that you control the information*

product and the process to come to that information. This can be used to position yourself [value adding companies] in the market. To be concrete: some customers cannot even accept an information product, if it is not certified, because then they are not insured. Certification is very important and we are working on this. The involved parties have to be certified. We agreed [together] on a complete process for that and how a company becomes certified.” [30].

These sector-wide approaches by NEVASCO in the value adding industry also help with capacity building within the sector to bring together the various different fields of expertise thereby also improving the entrepreneurial capabilities of the individual companies. The small companies that are active in the value adding sector are mostly technology-driven companies that lack the resources and abilities to explore potential new markets. However, by working together under the NEVASCO cooperation, these companies have more critical mass and have a bigger impact on future markets, as indicated in the study report on the Dutch value adding industry from 2014 [21]. The Senior Policy Advisor of NSO adds: *“Something like NEVASCO is a fantastic solution. Because then you are able to create mass and you can ensure that the cohesion and expertise you have in certain areas is unique and we feel that in certain application areas we are still frontrunners, but then you need to make sure you can realise that.” [33].*

NEVASCO is thus creating a movement in the value adding industry by building capacity to be able to deliver more products and services based on earth observation data to a wider and larger market of end-users. In this respect, NEVASCO’s activities directly contribute to the (utilitarian) popularisation of geo-information services.

4. Discussion and conclusion

The popularisation of geo-information services offers many high-potential opportunities that contribute to achieve Europe’s 2020 goals of becoming a “smart, sustainable and inclusive growth economy”[1]. The current trend of free and open access to earth observation data has the potential to unlock the benefits of geo-information services to the largest number of possible users. However, from a utilitarian perspective, access to the data is not the only barrier in future use on a large scale, since end-users frequently cannot readily utilize raw earth observation data in their business processes. The value adding companies that transform earth observation data into useful information for end-users are often small start-ups or university spin offs with specific areas of expertise. These relatively young and small companies typically face various barriers to gain impact in a new technology market due to a lack of (financial) resources and the inability to compete with well-established firms, which is referred to as liability of newness [10]. Moreover, these organisations and the market as a whole face several critical challenges on political, socio-economic and technological levels in transforming earth observation data into commercial services. Hence, the development of the value adding industry is currently both a bottleneck and an enabler in the value chain between earth observation data and geo-information services embedded in customer processes.

Our analysis shows how the establishment of the Dutch cooperation NEVASCO serves as a model (mechanism) to overcome various challenges in developing services for end-users based on earth observation data. NEVASCO thereby strengthens the value adding industry and contributes to the

popularisation of geo-information services. NEVASCO's mission is to better link downstream needs (market pull) with upstream availability (technology push). By coordinating the expertise of the individual value adding companies, the cooperation can deliver integrated geo-information services that are tailored to the needs of the end-user. In this respect, the formation of NEVASCO allows value adding companies to better explore new opportunities in new markets, ultimately stimulating the (further) spread of geo-information services. In addition, by joining forces under NEVASCO, the value adding organisations are able to overcome the liabilities of newness that young and small organisations suffer from [11,12], as cooperating allows them to manage their means more effectively. Moreover, (the formation of) a cooperation allows the value-adding industry to more effectively engage with policymakers to address industry related issues and coordinate actions towards further geo-information service spread.

The findings of this study highlight the importance for European policy makers to rebalance their focus from technology-push industry stimulation to more market-pull oriented interventions. Here, the government may, for example, act as an initial customer for geo-information services to stimulate new, or more diverse, services by the value adding companies. Although the allocation of governmental funding is an important element in encouraging the use of geo-information services, it is also necessary to enable and stimulate the value adding industry in further developing the market for geo-information services. In this respect, strengthening the value adding sector is not the sole responsibility of industrial actors or policy makers; rather it requires the important, yet challenging, alignment between industry activities and governmental incentives to overcome the prevailing challenges. Hence there needs to be a healthy balance between market initiatives and government intervention. To better align policy interventions to support the value adding industry, policy makers and industrial actors should work together in defining high potential market sectors. Such interplay would provide a solid foundation to stimulate the use of geo-information services on a larger scale.

In sum, this study enhances our understanding of the many challenges faced by the European value adding industry and provides insights in what a cooperation of value adding organisations can do to overcome various challenges, thereby contributing to the popularisation of geo-information services. In this respect, the learnings from NEVASCO serve as a source of inspiration for other European initiatives, such as EARSC on a European level that shares with NEVASCO similar networking and collective public lobby activities [40]. Moreover, from a policy perspective, our study also highlights the importance of the development of policies and funding schemes in cooperation with the value adding industry to stimulate the commercialization of geo-information services - ultimately, making the benefits of earth observation data available to the largest number of users possible.

Funding

This work was supported by the Netherlands Space office and the Eindhoven University of Technology.

Bibliography

- [1] European Commission, EUROPE 2020 - A strategy for smart, sustainable and inclusive growth, (2010). <http://ec.europa.eu/eu2020/pdf/COMPLET%20EN%20BARROSO%20%20%20007%20-%20Europe%202020%20-%20EN%20version.pdf> (accessed September 27, 2016).
- [2] Council of the European Union, Joint statement on shared vision and goals for the future of Europe in space by the European Union and the European Space Agency, (2016). <http://data.consilium.europa.eu/doc/document/ST-12808-2016-REV-1/en/pdf> (accessed January 9, 2017).
- [3] European Space Agency, Resolution “Towards Space 4.0 for a United Space in Europe,” (2016). http://esamultimedia.esa.int/docs/corporate/For_Public_Release_CM-16_Resolutions_and_Decisions.pdf (accessed January 9, 2017).
- [4] European Commission, COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS - Space Strategy for Europe, (2016). <http://ec.europa.eu/DocsRoom/documents/19442/attachments/2/translations/en/renditions/native> (accessed January 9, 2017).
- [5] R. Harris, I. Baumann, Open data policies and satellite Earth observation, *Space Policy*. 32 (2015) 44–53.
- [6] C. Giannopapa, Key Enabling Technologies and Open Innovation - New Impulse for the Space Sector, European Space Policy Institute, Vienna, Austria, 2010. http://www.espi.or.at/images/stories/dokumente/studies/espi%20report%2024%20online_1.pdf (accessed February 17, 2017).
- [7] ESA, Copernicus - Observing the earth, (n.d.). http://www.esa.int/Our_Activities/Observing_the_Earth/Copernicus/Overview3 (accessed September 27, 2016).
- [8] G. Sawyer, M. de Vries, About GMES and data: geese and golden eggs - A Study on the Economic Benefits of a Free and Open Data Policy for GMES Sentinels Data, EARSC, Brussels, 2012. earscl.org/file_download/134/Open+Data+study+Final+report.pdf (accessed September 29, 2016).
- [9] T. Secara, J. Bruston, Current barriers and factors of success in the diffusion of satellite services in Europe, *Space Policy*. 25 (2009) 209–217.
- [10] A.L. Stinchcombe, Social structure and organizations, in: J.G. March (Ed.), *Handb. Organ.*, RandMcNally, Chicago, 1965: pp. 142–193.
- [11] J. Freeman, G.R. Carroll, M.T. Hannan, The Liability of Newness: Age Dependence in Organizational Death Rates, *Am. Sociol. Rev.* 48 (1983) 692–710.
- [12] P. Singh, M. Märtsin, K. Glasswell, Knowledge work at the boundary: Making a difference to educational disadvantage, *Learn. Cult. Soc. Interact.* 2 (2013) 102–110. doi:10.1016/j.lcsi.2013.02.001.
- [13] T.A. Sutherland, B.G. Cameron, E.F. Crawley, Program goals for the NASA/NOAA Earth Observation Program derived from a stakeholder value network analysis, *Space Policy*. 28 (2012) 259–269.
- [14] P. Kansakar, F. Hossain, A review of applications of satellite earth observation data for global societal benefit and stewardship of planet earth, *Space Policy*. 36 (2016) 46–54.
- [15] NEVASCO, NEVASCO, Who We Are. (2015). <http://www.nevasco-group.nl/mission.html> (accessed December 23, 2016).
- [16] G. Dosi, Technological paradigms and technological trajectories, *Res. Policy*. 11 (1982) 147–162. doi:10.1016/0048-7333(82)90016-6.
- [17] R.K. Yin, *Case study research: design and methods*, 4th Edition, Sage Publications, Thousand Oaks, 2009.

- [18] F.J. Aguilar, Scanning the business environment, Macmillan, New York, NY, 1967.
- [19] W. Oosterveld, M. Gehem, P. Vermeulen, P. Wijninga, M. Rademaker, P. Sinning, Aardobservatie op de kaart, The Hague Centre for Strategic Studies, The Hague, 2016. https://www.thehaguesecuritydelta.com/media/com_hsd/report/60/document/HCSS-Aardobservatie-printversie.pdf (accessed January 9, 2017).
- [20] C. Giannopapa, Securing Galileo's and GMES's place in European policy, Space Policy. 28 (2012) 270–282.
- [21] Taakgroep Toepassingen Satellietdata o.l.v. voorzitter European Association of Remote Sensing Companies (EARSC), De Ruimte voor het Gebruik - Meer WAARDE voor onze Aarde, (2014). <https://www.rijksoverheid.nl/binaries/rijksoverheid/documenten/beleidsnota-s/2014/09/11/de-ruimte-voor-het-gebruik-meer-waarde-voor-onze-aarde/de-ruimte-voor-het-gebruik-meer-waarde-voor-onze-aarde.pdf> (accessed January 9, 2017).
- [22] G. van der Burg, P. Dieleman, S. Kampen, A. Selig, H. Werij, Topsector HTSM Roadmap Space 2015 - 2020, Lucht- en Ruimtevaart Nederland, Delft, 2015. <http://www.hollandhightech.nl/nationaal/innovatie/roadmaps/space/roadmap-space-issue2-2-2015-2020> (accessed January 9, 2017).
- [23] NSO, G4AW: satellietgegevens vergroten voedselzekerheid ontwikkelingslanden, Neth. Space Off. (2014). <http://www.spaceoffice.nl/nl/Nieuws/1692/G4AW-satellietgegevens-vergroten-voedselzekerheid-ontwikkelingslanden.html> (accessed January 4, 2017).
- [24] N. Bunnik, in: Ontwikkelingen Ned. Inzake Remote Sens. Vanuit Satellieten, Ministerie van Verkeer en Waterstaat, Den Haag, 2006: pp. 20–41.
- [25] NSO, Groei Nederlandse ruimtevaart cruciaal, (2015). <http://www.spaceoffice.nl/nl/Nieuws/1717/Groei-Nederlandse-ruimtevaart-cruciaal.html> (accessed January 9, 2017).
- [26] Ocean Space Consult, NEDERLANDS VALUE-ADDING SERVICES COLLECTIEF (NEVASCO), (2015). <http://oceanspaceconsult.com/nevasco-2/> (accessed January 9, 2017).
- [27] Interview with the founder of NEVASCO, (15th of August 2016).
- [28] Interview with the Senior Advisor for Science and Satellite Data Usage from the Netherlands Space Office, (15th of October 2015).
- [29] Minister of Economic Affairs, Kamerbrief nota over Ruimtevaartbeleid 2014-2020, (2014). https://www.rijksoverheid.nl/binaries/rijksoverheid/documenten/kamerstukken/2016/11/25/kamerbrief-nota-ruimtevaartbeleid-2016/Kamerbrief_nota_ruimtevaart_16169606.pdf (accessed September 29, 2016).
- [30] Interview with the Founder of NEVASCO, (30th of October 2015).
- [31] NEVASCO, Global Challenges & Opportunities for the Dutch Satellite Downstream Industry, (2015). <http://www.geo-informatie.nl/projects/glossy/2015/NEVASCO%208%20December%202015-Final.pdf> (accessed January 9, 2017).
- [32] Interview with the Advisor for Operational Usage from the Netherlands Space office, (13th of November 2015).
- [33] Interview with the Senior Policy Advisor from the Netherlands Space Office, (29th of November 2016).
- [34] Ministerie van Veiligheid en Justitie, Nationale veiligheid en crisisbeheersing, 13 (2015) 15–16.
- [35] NSO, Coöperatie van Nederlandse ruimtevaarttoepassingen op Hannover Messe, (2015). <http://www.spaceoffice.nl/nl/Nieuws/1708/Cooperatie-van-Nederlandse-ruimtevaarttoepassingen-op-Hannover-Messe.html> (accessed January 9, 2017).
- [37] Interview with the Business Developer of DeformCO, (27th of November 2015).

- [38] Interview with the Director of PipeCo, (30th of November 2015).
- [38] Ocean Space Consult, Nederlands Value-Adding Services Collectief (NEVASCO) - Definitiestudie, (2015). http://oceanspaceconsult.com/wp-content/uploads/2015/03/rapport-Definitiestudie-ADI_NEVASCO_Final1.pdf. (accessed September 30, 2016).
- [38] Interview with the Director of WaterCo, (21st of September 2016).
- [40] EARSC, About us, (n.d.). <http://earsc.org/about/> (accessed January 9, 2017).