Received: 19 February 2021 | Revised: 14 July 2021 | Accepted: 9 August 2021

DOI: 10.1002/met.2025

Meteorological Applications
Science and Technology for Weather and Climate
Open Access
RMetS

RESEARCH ARTICLE

Public–private engagement (PPE) in hydromet services and the role of the academic sector

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Abstract

National meteorological and hydrological services (NMHSs) play a key role in gathering data and in providing services like early warnings, basic weather forecasts or climate analysis. In most developing countries, NMHSs are public services facing hindering financial constraints and shortages of skilled personnel. Both the World Meteorological Organization (WMO) and academia play a long-standing role in creating, innovating and fostering technology and services in meteorology and hydrology (hydromet services). At the same time, the role of the private sector in weather service provision is strongly growing all around the world. In order to maximize socio-economic benefits from hydromet services, it is necessary that countries are considering how to strategically embrace the benefits that the private and academic sectors can offer without jeopardizing the provision of public services. A recent World Bank report suggests that public–private engagement (PPE) can create and sustain effective hydromet value chains. Moving towards PPE not only creates opportunities for the academic sector but in many instances critically depends on it for capacity building, to further develop trust relationships between the sectors, to provide spaces in which collaboration between the sectors can be tested and last but not least serve as a source and conduit for new technologies. This paper intends to stimulate discussion on PPE and the role that academics and academic institutions can take to foster sustainable hydromet value chains.

KEYWORDS

academia, global weather Enterprise, hydromet services, public–private engagement, R2O, socio-economic benefit, value chain

1 | INTRODUCTION

Effective weather, climate and hydrological services (summarized as hydromet services) are critical to protect lives and property and to enhance socio-economic benefits in most countries. The economic benefits resulting from the use of hydromet services are generally well documented (Freebairn & Zillmann, 2002; Frei, 2010; Leviäkangas & Hautala, 2009). For instance, the value of rainfall information at the level of the individual farmer is reflected in the increase in revenue generated from improved decisions associated with the additional meteorological and climatic information. This means that hydromet information acquires value only when the use of such information

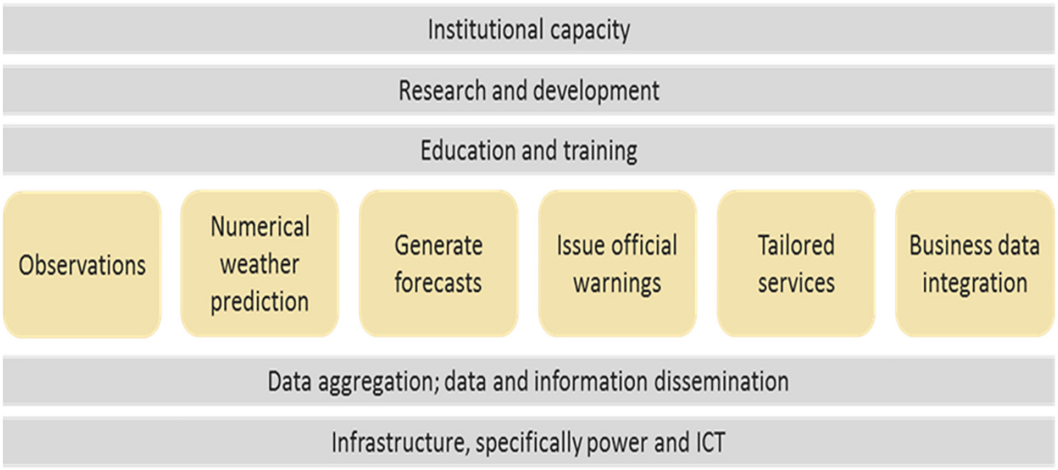

FIGURE 1 Simplified hydromet value chain (yellow) and key enablers (grey). The value chain should be read left to right (World Bank, 2019)

changes the behaviour of the user (Frei et al., 2014; Perrels et al., 2013; von Grünigen et al., 2014). Moreover, hydromet information is an important factor in the decision-making process of various industries. For instance, the energy industry uses meteorological information to optimize the generation, transmission and distribution of power, or to estimate the energy demand accurately and quickly.

National meteorological and hydrological services (NMHSs), which are traditionally public sector entities usually mandated to provide meteorological and hydrological services, are facing serious challenges in responding to increasing demands – especially in low- and some middle-income countries – due to lack of resources, technical capacity and visibility within their own government, among other reasons (WMO, 2014; Zillmann, 2003).

At the same time, the potential roles of, and dynamics between public, private and academic sectors in the hydromet domain have been evolving rapidly in recent years. While the private sector has been part of the so-called hydromet value chain (see Figure 1) for a long time, its role has been growing in recent years. New business opportunities for the private sector have been emerging thanks to the rapid development of information, measurement and telecommunication technologies, artificial intelligence (AI) and deep learning along with the availability of large and free datasets, as well as a stronger awareness of the economic benefits provided of using hydromet data by individuals and companies. This led to new companies developing various services within and along the hydromet value chain as well as large tech companies entering into the hydromet market. In order to maximize future socio-economic benefits, it is almost imperative that countries are considering how to strategically embrace the benefits of the growing private sector can offer without jeopardizing the provision of public services.

In this paper academia is not only associated with universities in terms of teaching but essentially with their research and development branches and the creation of corresponding start-ups. However research and development can also take place in government or private sector. NMHSs with their own research and development branches can accordingly compete or partner or both with academia and private sector research entities.

The academic community gives important indications on how to make private engagement successful in terms of innovations, access to networks and feedbacks for all users of meteorological and climatological services. Moreover, the academic sector also plays an essential role in providing innovation and training and education opportunities (WMO, 2018).

In many developing countries, the hydromet value chain is not well developed and development projects focusing only on the capacity of NMHSs are facing challenges (Rogers et al., 2019). Therefore, development projects that incorporate public–private engagement are seen as opportunities to provide better and sustainable solutions for modernizing national infrastructure and enhancing the access to and the quality of hydromet services needed by the national economy and citizens. Modernization or upgrades to the NMHSs funded by development banks and other development agencies have had mixed results. While the aim is to help the government and its agencies develop public services that meet the growing needs of society, the investments often fall short of this ambition. Rather than reiterate the problems and attempted solutions, one might draw on a different line of thinking about business practices and innovation (Rogers et al., 2021).

While the interaction among the public, the private and the academic sector is an old topic in the hydromet community, the discussion on how to leverage the cooperation

between the sectors has, however, gained momentum in recent years, not least because of the evolving role of the private sector and the challenges faced by the NMHSs (WMO, 2018, 2019a, 2019b; World Bank, 2019).

This paper intends to give an overview of the issues around the collaboration of the public, private and academic sectors and aims at stimulating the discussion on public–private engagement (PPE) and the role that academics and academic institutions can take to foster sustainable hydromet value chains.

2 | PPE IN HYDROMET SERVICES

PPE is – broadly speaking – defined as an inclusive partnership among public, private and academic sectors, as well as civil society, at global, regional and national levels. However, there is no clear definition.

In contrast to PPE, public–private partnership (PPP) is an older concept, already introduced in the 90s. PPP are formal arrangements between public and private counterparties to share risks and rewards in the delivery of, for example, public services and infrastructure. Critical success factors for traditional PPPs have been identified in many countries and different economic sectors. They can be categorized into seven groups: (1) equitable allocation of risks, (2) strong private sector, (3) judicious government control, (4) transparent and efficient procurement process, (5) project economic viability, (6) adequate legal framework and stable political environment and (7) available financial market (Chan et al., 2010). A successful PPP enables a long-term integration of multiple stakeholders and a volatile and dynamic development process (Chinyio & Gameson, 2009; Grimsey & Lewis, 2005; Raisbeck et al., 2010; Yong, 2010). Effective process management has been acknowledged as a factor necessary for stakeholder satisfaction and for project success in PPPs (Koppenjan, 2005). Public–private partnerships (PPPs) have often failed because the allocation of risk has not been equitable and the role of the public sector as an innovator has not been recognized, resulting in failures to achieve a symbiotic PPP (Mazzucato, 2013). Many potential PPE activities fail also because of unwillingness to share IPR (intellectual property right), giving one party effective control over the product.

While these findings for a successful implementation of PPP may be of some importance for hydromet PPE, they must be adapted and tailored to hydromet value chains and the specific role each sector plays in the hydromet domain. For example, efficient, transparent procurement processes for building a large dam are not suitable for rapidly building up and maintaining networks of automatic weather stations. The looser association and flexibility of PPE rather than the formal contractual arrangements normally associated with PPP is an important distinction that also recognizes that constructive engagement also includes competition.

The recently published World Bank/GFDRR Study on Public and Private Engagement in Hydromet Services (World Bank, 2019) offers an in-depth discussion of the topic and formulates a set of key aspects a country needs to take care in order to achieve effective hydromet public–private engagements. The publication is based on more than 50 interviews with stakeholders from the public and academic sector and representatives of national and international companies as well as case studies on developing and developed countries. The study stresses the importance of focusing on the entire hydromet value chain, paired with the development of an overall strategy at the country level to maximize socio-economic benefit.

2.1 | Understanding values and value drivers

In order to recognize where each sector can add value, it is crucial to understand what drives the participants in a PPE. First, the participants in a successful PPE must share a common set of values. This is the basis on which conflicts of interest and misalignment of organizational priorities can be managed. Value drivers translate to organizational goals that support one or more shared values. They can be shared among organizations, but they can also conflict. Table 1 illustrates a set of possible shared values and value drivers for the participants in a hydromet value chain PPE. The list is not exhaustive and exemplary in nature as shared values and value drivers have to be defined for each PPE or set of PPE activities in a country.

2.2 | From supplier/customer relations to partnerships

Evolving from the ‘classical’ public–private engagement options where one side is the supplier and the other side is the customer of hydromet equipment, data or services, there are interesting options for public–private engagements with a stronger emphasis on partnership. However, such a development from supplier/customer understanding to partnership requires confidence-building measures and a permanent exchange of opinions.

In developing countries, international providers might fill gaps in the provision of weather services while in-country capabilities are being built up or could be strategic partners to strengthen the hydromet value chain (Rogers et al., 2019).

TABLE 1 Commonalities and differences between typical drivers found in the public, private and academic sectors

	National meteorological and hydrological service	Private sector	Academia
Shared values	Lives and property Socio-economic benefit National security		
Value drivers (goals and actions that increase value)	Effective hydromet value chain		
	National and international data exchange		
	Sustainable public services	Market-oriented non-public services	Research projects and publications
	Cooperation between government agencies		
	Cooperation in the hydromet value chain		
	Routine operations	Flexibility	Teaching

2.3 | The role of NMHS

A strong influence on the operation and efficient delivery of services is given by the governance structure of an NMHS. This organizational structure of NMHSs can vary considerably from country to country.

There are different types of NMHSs, which include government agencies, semi-autonomous government agencies, government-owned organizations and private companies. Countries where private and government-owned agencies exist, effort needs to be made to assure clear responsibilities to minimize any potential conflicts.

In that sense, the economic properties should be taken into consideration, especially when designing the regulatory framework that governs the delivery models for different hydromet services (Rogers et al., 2019).

2.4 | The role of WMO

The World Meteorological Organization (WMO), as an agency of the United Nations, provides world leadership and expertise in international cooperation in the delivery and use of high-quality, authoritative weather, climate, hydrological and related environmental services by its members, for the improvement of the well-being of societies of all nations.

A major role of the WMO Policy Framework is to establish a set of basic principles to provide directions, express responsibilities and goals. The PPE policy framework steps on the core values and goals of the WMO as an organization and serves two main tasks: to guide an effective engagement of the public, private and academic sectors in the GWE (Global Weather Enterprise), and to guide members' intentions and efforts in expanding the public–private–academic partnerships for ensuring better service to their governments, business and citizens (Rogers et al., 2019; WMO, 2019b).

WMO recognized the importance of a successful interaction between the public and private community and established the Geneva Declaration – 2019: Building Community for Weather, Climate and Water Actions (WMO, 2019c).

3 | ROLE OF ACADEMIA IN SUCCESSFUL PUBLIC–PRIVATE ENGAGEMENT IN HYDROMET SERVICES

Public–private engagement (PPE) is defined as an inclusive partnership between public and private. Academic institutions are either public or private, and most of their research is financed by the public. In the case of hydromet services, the academic sector might enhance this process and play a key role in fostering potential results.

3.1 | Innovation through data sharing and collaboration

Academic research and close to the real-world teaching in the hydromet domain heavily rely on hydromet data. Therefore, the academic sector needs continued access to observational data and prediction products for weather and climate. Public–private engagement can facilitate data sharing, also with academia in terms of corresponding contracts, although an open data policy might be more powerful.

Shared data are a base for academic research to help generating the basis for new products and services. Academic research and innovation via spin-off companies

can interact in such an environment with the public sector (Figure 2).

The interactions among the different sectors are strongly influenced by measuring and computing innovations such as crowd-sourced sensor data, big data analysis, internet of things (IoT) or AI. For example, privately owned vehicles become increasingly connected to each other and external infrastructures via a growing number of sensors, a massive amount of data is being generated. This growth in connected vehicles will give automotive manufacturers the opportunity to differentiate from their competitors in many areas. An example is enhanced navigation: navigation systems will provide up-to-the-minute information about traffic and comprehensive weather conditions. Such a generation of additional weather data in cars, as, for example, operationally done by Met Norway, is interesting again as input data in weather models operated by NMHS's or by academia.

Innovation can be fostered by a clear and effective R2O process (research to operation) as shown by the ECMWF (European Centre for Medium-Range Weather Forecasts) with the six following steps: planning–development–testing–implementation (into operations)–evaluation (and diagnostics)–communication (ECMWF, 2017). The academic sector, including international research institutes, plays a crucial role in the R2O process in order to develop new methods, tools or even products that might become operationalized by the private sector.

Apart from ECMWF, successful interactions with academia are, for example, also the Global Framework for Climate Services (GFCS) or the National Center for Atmospheric Research (NCAR). In both cases, academia plays a key role in fostering new products or methods in collaboration with NMHS's and other partners.

Since the late 1980s, some NMHSs, especially in Europe – but today also NMHSs in other regions – started to charge for certain data and products as they started commercial activities (Pettifer, 2015; Zillmann, 2003), although, especially in Europe, NMHSs in some countries have implemented strategies for mainly public services and gave up commercial activities (e.g. Germany, Israel, Switzerland).

For a successful interaction with the academic sector in terms of innovations, any charges are, however inhibiting, even small charges or complicated processes might inhibit the academic 'discovery processes'.

3.2 | Education and reaching out

Academia can help to reach end-users, fill capacity gaps in developing countries and train the trainers. Academia has done this for a long time and can now increasingly take advantage of private sector resources. For example, Wageningen University in The Netherlands coordinates a project where farmers in Bangladesh and Ghana are educated about the weather,[1] and where weather forecasts are used as the basis for farming advice. Teaching materials are created with live online materials from a private sector weather service, meteoblue.com, that also sponsors forecast data. Anecdotal evidence indicates that this approach works.[2]

Note that in such projects, a number of capabilities in addition to hydromet expertise are required, including teaching in rural communities, different cultures, training the trainers, agricultural advice and so on. NMHSs from developing countries often struggle because of limited domestic qualified people. PPE might recognize these long-term needs of the sector and help academia prepare the workforce for the future, which includes a broader education where meteorologists do not just understand meteorology or physics, but also stakeholder engagement, big data and AI to meet future needs.

3.3 | Build capacity

Academia might also benefit from interactions with private sector and NMHS in the form of PPE by establishing teaching programmes, teaching cases, contribution to research and finally by used elsewhere in other projects.

3.4 | Mutual benefits

The role of the academic sector in successful public–private engagements has been proven by the interaction of the European Commission research programme with industry. There are now several successful infrastructure projects like Clean Sky[3] or Shift2Rail demonstrating successful collaboration on a PPE basis.

The benefits of PPE for universities and for the industry are summarized in Table 2.

[1]http://www.waterapps.net/en-us/general-news/

[2]https://www.youtube.com/watch?v=6sGOOjAXxF8

[3]Clean Sky (European Union, 2019) is the most ambitious aeronautical research programme ever launched in Europe. Its mission is to develop breakthrough technologies that significantly increase the environmental performances of airplanes and air transport, resulting in less noisy and more fuel efficient aircraft. The Clean Sky JTI (Joint Technology Initiative) was created in 2008 and represents a unique public–private engagement between the European Commission and industry. It is managed by the Clean Sky Joint Undertaking (CSJU).

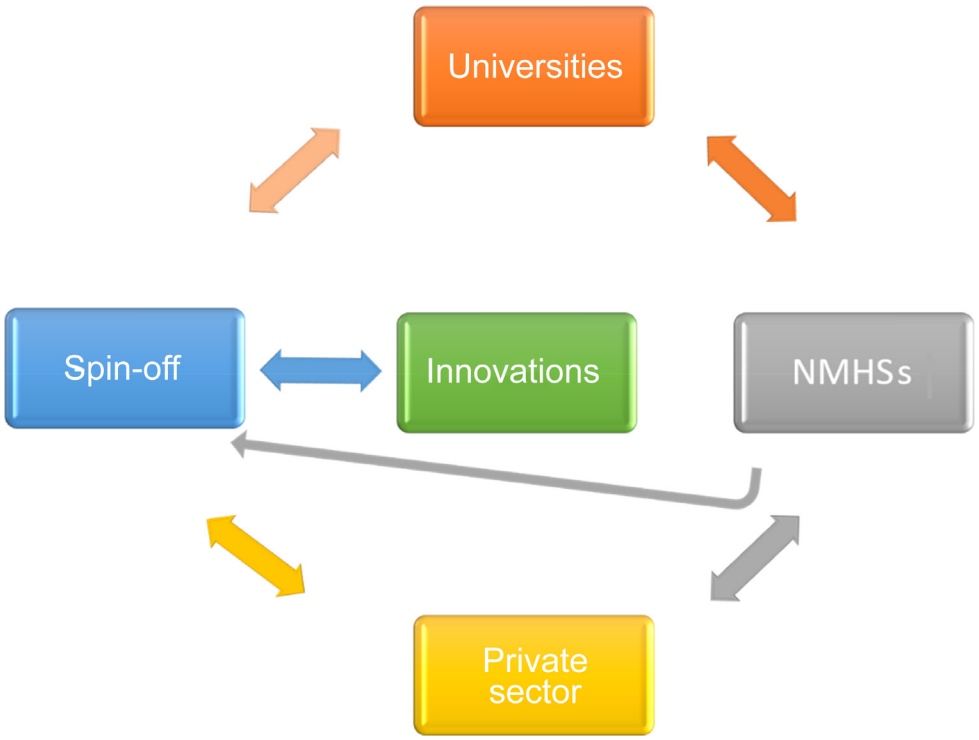

FIGURE 2 Interactions of the public and private sectors with the academic sector. NMHSs, national meteorological and hydrological services

TABLE 2 Benefits of public–private engagement for academia and industry

#	Benefits for universities	Benefits for industry
1	Industry partnerships give students and faculty additional funding	Successful companies were started at universities, and the success rate of university start-ups is high. Universities are pushing boundaries and leading science – and industry wants to get in on the ground level
2	Industry feedback and guidance	Companies are hungry for ideas, and the actual technologies and intellectual properties to commercialize those ideas. Companies are hungry for talent
3	Students getting jobs, often with the universities' partner companies	Access to a network of faculty, key opinion leaders and lead scientists
4	The pipeline from research student to employee is powerful public relation (PR) for universities	Collaborating with universities allows companies to 'de-risk' their research and provide research cost avoidance, saving them money
5	Hot market for entrepreneurial-minded, experienced graduates puts students in the driver's seat when it comes to choosing a career path	

4 | DISCUSSION AND CONCLUSIONS

4.1 | World Meteorological Organization interaction between the public and private community

The protection of lives and property is part of any government's core mandate; the provision of adequate basic hydromet services can be considered part of this mandate. The creation of additional social-economic benefits should be one of the ultimate goals of a national meteorological and hydrological service (NMHS), whether directly or indirectly, through data and services provided to the private sector. The impacts of weather service data policies on national security need to be carefully assessed, as measures overly restricting the exchange of data may severely hinder the cooperation between the public, the private and the academic sector as well as the international cooperation.

Development projects that incorporate public–private engagement have the potential to provide sustainable

solutions for modernizing national infrastructure and enhancing the access to and the quality of the requisite services needed by the national economy and citizens. The academic sector has also an important role in such partnerships by bringing innovation and training and education opportunities (World Meteorological Organization [WMO], 2018).

The WMO, as an agency of the United Nations, provides world leadership and expertise in international cooperation in the delivery and use of high-quality, authoritative weather, climate, hydrological and related environmental services by its members, for the improvement of the well-being of societies of all nations.

A major role of the WMO Policy Framework is to establish a set of basic principles to provide directions, express responsibilities and goals. The public–private engagement (PPE) policy framework steps on the core values and goals of the WMO as an organization and serves two main tasks: to guide an effective engagement of the public, private and academic sectors in the GWE (Global Weather Enterprise), and to guide members' intentions and efforts in expanding the public–private–academic partnerships for ensuring better service to their governments, business and citizens (WMO, 2019a, 2019b).

WMO recognized the importance of a successful interaction between the public and private community and established the Geneva Declaration – 2019: Building Community for Weather, Climate and Water Actions (WMO, 2019c). Much more data from diverse traditional and non-traditional sources are expected to become available, and this will create huge opportunities to improve and generate new services. Data providers will come from all sectors – public, private and academic.

4.2 | Transnational perspective

An additional essential aspect is the transnational perspective of international weather companies for a successful PPE. The continuous advancement of communication technologies, sensors and computational resources results in an ever-increasing availability of hydromet services. The way people receive up-to-date information and conduct business is shifting rapidly towards internet and mobile-based services. Often, the apps and websites of international providers are simply easier to use and present information better to end-users. In many cases, forecast models and post-processing for localization of the forecast can produce forecasts of adequate quality for most users. Even if the NMHS forecasts are significantly better in quality and accuracy, many users may prefer the more attractive user interface of an international provider.

In developing countries, international providers might fill gaps in the provision of weather services while in-country capabilities are being built up or could be strategic partners to strengthen the hydromet value chain (Rogers et al., 2019).

Historically there were several examples of public services like post or telecom, which have been reorganized due to technological changes (Waverman & Sirel, 1997). The original public services have been liberalized or even privatized in several countries with a strong market control unit by the government established to control quality and prize of the services. One option of public–private engagement in the context of NMHSs might be to further develop in such a direction, that meteorological services are more provided by private companies but regulated by an independent and strong governmental body ensuring quality, integrity and availability of the meteorological and hydrological services. Open and free data access is always a critical success factor for such a model (Furshpan, 2017) in order to enable innovations by the academic sector.

4.3 | Next steps

Finally, the overview of analysing successful private–public engagement indicates that the roles of all involved stakeholders combined with a comprehensive legal frame might generate the necessary win–win situation for all partners. Collaboration instead of competition among public, private and academia might therefore be the way forward. The final goal is that PPE can generate benefit to society and economy with its new and innovative meteorological and climatological services.

Concrete next steps might be an opening of governmental organizations like WMO or UNFCCC for the private and academic sector and to involve them in technical commissions and boards. This might then act to enable confidence-building and closer cooperation. It is necessary that all involved parties in PPE (NMHSs, academia, private) meet at eye level.

The role of the academic sector in fostering the R2O process in order to develop new methods, skills or products in meteorology and climatology should gain more awareness. Joint Technology Initiative, as established, for example by the European Union, might then be a way to interact between public research and private companies on a PPE basis. The academic sector might hence play a key role in interdisciplinary research and also education in PPE as there are successful examples like NOAA and its cooperative research centres or ECMWF's (European Centre for Medium-Range Weather Forecasts) cooperation with the private sector on their future computing systems.

National and international calls for proposals could enhance successful PPE of academia, NMHSs and private companies by requiring that three parties must be involved in order to meet the requirements.

ACKNOWLEDGEMENTS

I would like to thank Christoph Ramshorn, Stefan von Grünigen, Makoto Suwa and Anna-Maria Bogdanova for the discussion of the manuscript.

CONFLICT OF INTEREST

The author declares no conflict of interest.

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How to cite this article: Frei, T. (2021). Public–private engagement (PPE) in hydromet services and the role of the academic sector. *Meteorological Applications*, *28*(5), e2025. https://doi.org/10.1002/met.2025