Investing in Digital Hydrometeorological Data for the Developing World

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Abstract

Addressing many of the global challenges facing humankind requires the availability, access, and use of huge volumes of digital hydrometeorological (hereafter "hydromet") data needed to inform decision-making to save lives and infrastructure as well as to exploit the associated economic opportunities. The global challenges include the world's increasing vulnerability to weather, climate, and water stresses, and they are especially acute in developing countries. This technical note outlines the opportunities and requirements for developing countries to be able to benefit from the digital hydromet data revolution.

Technical Note from the series on specific aspects of Public and Private Engagement in Hydromet Services

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The digital data revolution

The COVID-19 pandemic has underlined a key trend in society that will only accelerate as the global challenges of climate change, migration, food security, and poverty alleviation are addressed. This trend is the growing need for the availability, access, and use of digital hydromet data in almost all areas of life. These data are essential for characterizing the current (and past) state of these challenges and for feeding into models that predict or project what is likely to happen in the future, upon which societal action can be based. For the science and technology–based community, the need for reliable, accurate data is obvious, but—as seen during the pandemic—the public, and even some decision-makers, found this reliance on data (that is, this reliance on evidence) to be something both new and sometimes bewildering. The era of big data is upon us. It is changing, and will continue to change, how society copes with global challenges. This data transition has been variously referred to as the "fourth" and "fifth industrial revolutions."[1] The availability of these rapidly growing volumes of data represents a huge opportunity not only to deal with the challenges but also to enhance societal productivity and well-being.

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Building back better and fairer post-pandemic is an opportunity, for example, to address climate change by focusing on decarbonization through a "new economy" (an economy that encompasses resilience, productivity, and efficiency for a sustainable world).[2] Our response to what has been characterized as an existential threat can be an opportunity both to address anthropogenic climate change and its myriad impacts and to provide an economic and societal stimulus. Digital hydromet data can help compensate for the costs of action to tackle this societal challenge because they create economic benefits if the data are fully and pervasively used throughout the economy. In essence, the value of weather, climate, and water information is not yet being fully realized (Thorpe and Rogers 2021). However, the challenges of transitioning to such a new economy cannot be underestimated; and these challenges are particularly acute in developing countries.

The demands and economic opportunities of the new economy can be met only if the accuracy, reliability, accessibility, and application of all forms of digital hydromet data is significantly improved. As an example, while it has been realized for some time how valuable weather, water, and climate information is for saving lives and limiting damage to assets, there has been less focus on the economic opportunities created by such information. However, as the volume (and quality) of weather, climate, and water information increases, access to the information and the ability to use it effectively are becoming critical requirements; without support, these requirements will become obstacles. Again, developing countries are in general significantly and negatively impacted by poor access and ineffective use of the highest-quality hydromet data, but the problem is not confined to the poorest countries.

Besides addressing the fundamental issue of the impacts of a warming planet, the potential benefits of these data exist in many sectors of the economy, including aviation, maritime, road and rail transport, agriculture, energy, insurance, tourism, and retail. Specific benefits of high-quality data include greater access to cheaper and more reliable electricity supplies to spur economic activity within otherwise marginalized groups; better health outcomes by improving air quality and coping with extreme temperatures in the built environment; more efficient and safer transport systems; and improved food security through more efficient management of soil nutrients and water use. Each of these potential benefits is highly weather sensitive, meaning that, in order to realize this potential, high-quality weather, climate, and water information is essential.

Using digital hydromet data

How can digital hydromet data enable these societal and economic benefits to be realized in developing countries? Rapid decarbonization in the face of the immediate threats caused by climate change creates both dangers and opportunities for sustainable economic development. It is clear by now that all economies are increasingly impacted by weather events, including both extreme and non-extreme weather. The frequency and intensity of life-threatening events are being impacted by climate change. Potential solutions to mitigate the impact of climate change are also highly sensitive to the weather, and without adequate information on the state of the atmosphere it will be very difficult to manage these solutions sustainably. The recent experience in Europe of long periods of low wind speeds and therefore low output from windfarms, coupled with shortfalls in gas supplies, highlights the potential difficulties that fully or even partially decarbonized economies may face. By utilizing seasonal global and regional weather forecasts, high-quality and high-resolution weather information enhances economic productivity and output. Consequently, building a resilient, efficient, and productive future economy (a new economy) will be enabled by next-generation weather information when it is integrated with a wide range of other digital data to inform decisions.

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Specific essential developments of the new economy include:

Energy efficiency will be essential. Managing how we heat and cool homes and workplaces, run transportation networks, operate industrial and domestic appliances, and charge vehicles are all tied to the availability of a primary stable renewable energy supply.

Food, water, and ecosystem security will be essential. Agricultural practices in many places need to evolve to increase productivity while reducing or eliminating practices that produce greenhouse gas emissions. Water resource management will need to be more adaptive to cope with the competing forces of drought, floods, and the requirements of multiple users. Natural and human ecosystems are critical elements in our efforts to mitigate and adapt to climate change.

Poverty reduction will be essential. Further marginalization of the poorest must not happen. To avoid this will require active interventions to ensure that the new economy contributes to eliminating poverty by creating economic opportunities where they currently do not exist. Moreover, the poorest will be exposed to greater adverse impacts than those who are better off, so weather and climate information to reduce such risks is essential. Addressing these issues requires consideration within developing countries on the part of politicians, planners, and developers of the new economies of a number of underpinning issues, such as:

- Determining the structure of the new economy and how to enable weather-related information to support it,
- Identifying the prospects for stronger, more resilient societies and economies in the future; ensuring inclusivity and reduced societal marginalization,
- Becoming aware of the sensitivity of these economies to the state of atmosphere and that managing the economy requires extensive measurements of the natural environment, and
- Enabling national capability—including in hydromet, computing, and data sciences—to be able to exploit digital hydromet (and other) data and associated services within country.

Because weather, climate, and water availability are globally interconnected, nations need access to digital data resources from across the globe. For example, a weather forecast for a given region depends on information about remote (in space and time) atmospheric events. Data about current conditions and future predictions are, in principle, able to be shared internationally across the global weather enterprise.[3] However, while there is a continual need to boost the quality of the data (by scientific and technological innovation), key obstacles—particularly for developing countries—remain regarding the access to, the availability of expertise to use, and the ability to manipulate the data from national and international data repositories such as emerging dedicated (computing) clouds.[4] A revolution is needed to provide access to the data pipelines, computing, and software infrastructure, as well as local expertise to use these data. Overcoming these obstacles is a priority for development investments. Addressing the weakest links in the value chain that link basic information (such as observations of the weather) to the sophisticated use of global and regional predictions by many actors in the economy becomes a priority.

Whilst there is a continual need to increase the quality of the data (by scientific and technological innovation), key obstacles particularly for developing countries remain regarding the access to, expertise to use, and ability to manipulate the data from national and international data repositories such as emerging dedicated (computing) clouds.

While investing in computing infrastructure and related software is important, so is capacity building to enable these technologies to be effectively utilized within developing countries. To be more specific, *capacity building* would involve enhancing education and training in weather and climate science as well as computing and data sciences in schools and universities. And *computing infrastructure* would include the hardware and software to connect to the internet at the highest bandwidths and speeds to enable access to digital data generated both within and outside the country. In addition, there are institutional developments that need to go hand in hand with infrastructure and technical capacity building. These include creating an enabling environment for a data-driven economy, including appropriate policy and legal/regulatory frameworks. To achieve decarbonization and most other Sustainable Development Goals in developing countries, these obstacles and opportunities need to be addressed. Development agencies and financial institutions can increase investments to tackle these issues. In addition, for the new economy to seize the digital hydromet data revolution, many stakeholder communities in developing countries need to be ready for and contribute to the transition to a data-driven society. This includes not only those with expertise in, say, hydrometeorology but also entrepreneurs who can benefit financially from data-driven efficiencies in their provision of goods and services to customers. It includes governments and decision-makers creating the environment that supports the development of the digital-data revolution. The incentives to make these changes come not only from the enhanced saving of lives and assets from hazardous weather and climate events but also from the economic growth opportunities that digital hydromet data can provide to businesses and the economy more widely.

Moreover, there are great benefits for developed countries from improved meteorological infrastructure in developing countries. Many developing countries have only sparse observational data. This has a significant detrimental effect on the accuracy and quality of the weather, climate, and water predictions created by the main global weather centers, which are located in highly developed countries. These inaccuracies are not confined to data-sparse regions because errors in global predictions propagate around the globe quickly. It therefore becomes important for weather information everywhere to have these deficiencies addressed.[5] Furthermore, observational data taken locally—even if they are not available in real time to be used in the prediction models—play a vital role in helping improve the physics of the models by acting as independent evaluation data after the fact. Consequently, investments in developing countries are beneficial for everyone.

As well as the dramatic growth in the volume of data, there is a revolution taking place in using data analytics, via machine learning and artificial intelligence, to merge data from many different aspects of society. This can both enable signals to be distinguished from noise and enable data regarding one aspect to inform seemingly disparate yet indirectly related aspects. These merged data form the basis of what can be referred to as "integrated services," whereby, for example, a commercial or industrial process that depends on a multiplicity of factors can be optimized given the appropriate merged data and the analytical tools. In addition, new modeling systems—such as digital twins of planet Earth as seen in the Destination Earth initiative[6]—will soon be making available much more detailed, policy-relevant, and usable data.

The economic benefits of access to the enhanced data will be more than enough to cover the costs involved in their production.

Concluding remarks

The new economy requires a step change in the access to and use of the highest-quality digital hydromet data. Much of the globe's highest-quality hydromet data are, in principle, freely available, but in too many developing countries a lack of the requisite information and communication technology (ICT) infrastructure to access these data and national expertise to use it are limiting factors. Developing countries need to find a way to use global data to the maximum extent possible while also maintaining and upgrading those national observation systems that are affordable.

As well as the more established uses of these data to save lives and protect infrastructure, the new economy presents real opportunities to use weather, water, and climate information to stimulate economic development and prosperity. To be more efficient, the new economy requires enhanced data with higher quality, higher resolution, longer history, and so on. The economic benefits of access to the enhanced data will be more than enough to cover the costs involved in their production (Kull et al. 2021). Investments to assist developing countries undertake this transition need to be made while taking a holistic view of the potential social and economic benefits of the information. The transition will involve infrastructure investments aimed at the near-term economic recovery as well as the long-term sustainable development of countries.

Digital data access, usability, and expertise are fundamental requirements if these benefits are to be realized. This access may be best achieved via public-private sector cooperation and international exchanges of data, which require not only in-country investment in the traditional infrastructure (for example, in meteorological observing equipment such as radar and automatic weather stations) but also in technological innovation in data access and usability afforded by developments in computing and artificial intelligence. And, crucially, the data access must be used as an opportunity to stimulate the whole economy by enabling (often commercially) tailored and integrated services to be provided within multiple economic sectors. The gearing obtained by ensuring multiple uses of weather, climate, and water information within the economy is crucial to maximize the positive economic impact on each country.

Notes

1. The "fourth industrial revolution" is characterized by a fusion of technologies that blurs the lines between the physical, digital, and biological spheres. It is disrupting almost every industry in every country, transforming entire systems of production, management, and governance; see the World Economic Forum's 2016 paper "The Fourth Industrial Revolution: What It Means, How to Respond," available at https://www.weforum.org/agenda/2016/01/the-fourth-industrial-revolution-what-it-means-and-how-to-respond. The *fifth industrial revolution* attempts to align the fourth industrial revolution toward serving humanity by connecting innovation to purpose and inclusivity; see the Oxford Economics 2021 blog post "In the 5th Industrial Revolution, creativity must meet technology," available at https://blog.oxfordeconomics.com/world-post-covid/in-the-5th-industrial-revolution-creativity-must-meet-technology

2. See World Economic Forum reports such as *Dashboard for a New Economy: Towards a New Compass for the Post-COVID Recovery*, 2020, available at https://www.weforum.org/reports/dashboard-for-a-new-economy-towards-a-new-compass-for-the-post-covid-recovery

3. Guidelines and resolutions of the World Meteorological Organisation (WMO)—the responsible United Nations body—have enabled data-sharing protocols and computing networks to help expedite access. Details about the WMO Unified Data Policy Resolution (Res. 1) are available at https://public.wmo.int/en/our-mandate/what-we-do/observations/Unified-WMO-Data-Policy-Resolution

4. For example, the European Weather Cloud is coordinating with European Meteorological Infrastructure (EMI) and their users. Details are available at https://www.europeanweather.cloud/

5. The Global Basic Observing Network (GBON) project of the WMO aims to start addressing some of the observational data gaps; the project is backed up by international finance via a Systematic Observations Funding Facility; for details about GBON, see https://community.wmo.int/gbon

6. Information about the Destination Earth initiative is available at https://digital-strategy.ec.europa.eu/en/policies/destination-earth

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