APEC Project: DESG 01 2021A

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SUMMARY REPORT

APEC REPORT ON NEW TECHNOLOGIES FOR ENVIRONMENTAL MONITORING

I. GENERAL INFORMATION

The year 2030 marks a milestone in the evolution of the global effort to steward the progress towards economic, environmental and social dimensions of sustainability. One of the most critical conditions for the fulfilment of the ambitions expressed in the 2030 Agenda for Sustainable Development is the effective and efficient use of dynamic and disaggregated data for decision-making.

Most notably, the 2030 Agenda recognizes the value that geospatial information provides to enable informed, data-driven decision-making. Access for citizens and civil society to data about the environment is considered to be a crucial condition for civic engagement in and public deliberation on environmental policies. Information is an important political resource in the struggle to build a sustainable future.

Some developing economies are undergoing rapid growth resulting in increased wealth. As a result, pollution is increasing the risks of unsustainable development. Developing best practices and technologies to acquire and process information will potentially help to reduce poverty, foster development and growth while preserving the environment. Information and Communication Technologies (ICTs) have the potential to contribute to sustainability, while simultaneously, being fundamental in facilitating information flows among stakeholders, improving environment protection, increasing the effectiveness of emergencies' management, and providing real-time decision support to accelerate and enhance environmental monitoring.

To bridge the knowledge gap and strengthen our ties and commitments with sustainable development, it ´was necessary to collect the experiences of economies having achieved greater development in using this technology, and therefore avoid repeating unsuccessful experiences and / or identifying key elements to ensure success. Experience sharing amongst specialists should lead to creating new research projects, promote information sharing and lead to setting up a network of remote sensing experts and / or entities among APEC member economies.

It is important to highlight that appropriate implementation of environmental monitoring technologies allows gathering data that contributes to improving the development and design of public policies aimed at effectively abating environmental pollution. Additionally, throughout the COVID-19 pandemic, these digital technologies have

helped to improve monitoring of economies by replacing on-site surveillance.

II. PRE-WORKSHOP RESEARCH

- Survey.

The objective of the survey was to identify the present level of adoption of remote monitoring in each member economy. Unfortunately, not all economies completed the survey.

However, the survey results yielded some insights into the current status of the remote environmental monitoring system in APEC economies, and addresses potential synergies between remote sensing, and new information technologies, and artificial intelligence.

In this initial review, we scrutinized progress at the regional level in order to promote, in the near future, greater collaboration between APEC economies to improve and strengthen remote environmental monitoring.

It should be borne in mind that the concept of monitoring is much broader than a simple technical aspect of geographic observation, since it involves:

- a socio-technological system in which various professional areas and specialties come together and connect with each other;
- a system of inter-institutional interests because it encompasses the interests of social, political, economic, environmental regularization, land use planning, energy policy, and even domestic security institutions;
- a continually evolving structure that embraces new elements resulting from expanding scientific knowledge, technology upgrades and changing laws and regulations.

The quality of the information provided depends on the efficiency of the environmental monitoring system and is critical to assess the status of the environment and for sound decision making. Thus, an environmental monitoring system plays a role of crucial importance in the administrative organization for the comprehensive and ecosystemic management of natural resources.

Strengthening the environmental monitoring system, complementing it with social and economic considerations, and addressing issues including assuring the quality of information gathered, validating databases, and the assuring monitoring stations effectively depict environmental status will make it possible to create a practical and efficient administrative tool to strengthen the process conducive to a comprehensive and ecosystem-based management of natural resources.

It is worthwhile mentioning this preparatory workshop research shall not be regarded as a handbook for operations but rather an initial view of the condition found in the respective economies, their needs and main interests so that the speakers may address the key points of greatest interest for each of the participating economies.

a. Findings - identification of the current level of adoption of the remote sensing technologies in some economies.

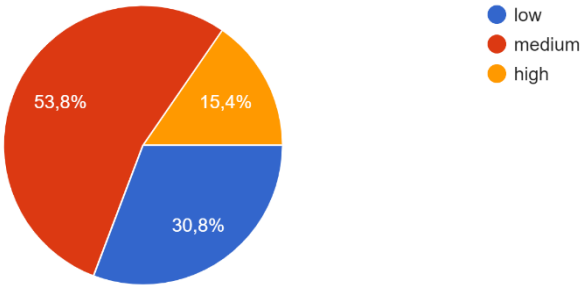
One of the research findings shows that in some economies more than one institution is charged with monitoring, with different levels of progress and/or development.

The results of the survey are shown below, based on the answers received through March 22, 2022

Economy	Agency	Web
Chile	SMA	https://portal.sma.gob.cl/
Mexico	PROFEPA	https://www.gob.mx/profepa
	CONABIO	https://www.gob.mx/conabio
	CONAFOR	https://www.gob.mx/conafor
Peru	OEFA	www.oefa.gob.pe
	OSINFOR	https://www.gob.pe/osinfor
	ANA	www.gob.pe/ana
	MTC	https://www.gob.pe/mtc
Philippines	PAGASA	https://bagong.pagasa.dost.gov.ph/
	DOST-PCIEERD	https://pcieerd.dost.gov.ph
Chinese Taipei	Environmental Protection Administration	https://www.epa.gov.tw/ENG/
United States	U.S. Environmental Protection Agency	https://www.epa.gov/
Thailand	Ministry of Natural Resources and Environment	http://www.mnre.go.th/en/

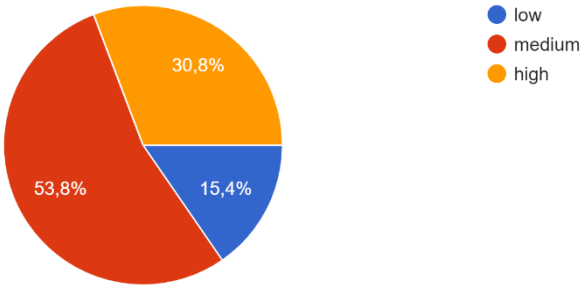
Which level of remote sensing technology you consider your institution/agency has?

13 respuestas



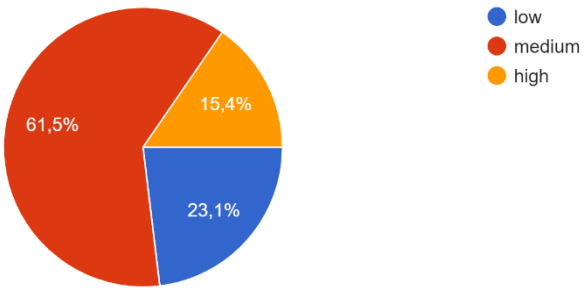
What is the current level of knowledge about satellite image analysis?

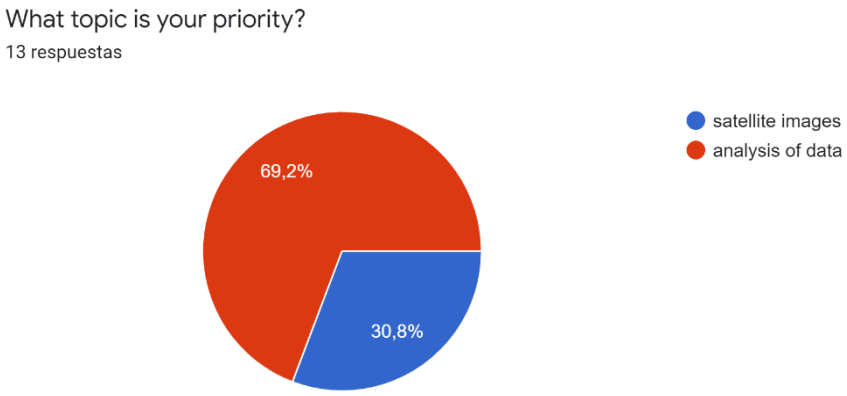
13 respuestas



What is the current level of knowledge about data processing:

13 respuestas





b. Conclusions

- Most of the economies have accomplished intermediate level of progress regarding the use of remote sensing technology. This shows much remains to be learned and put into practice.
- Economies place a strong focus on data analysis.
- Some institutions do not carry out remote monitoring, but they do perform monitoring tasks, thereby their need for training in data analysis.

III. WORKSHOP DESCRIPTION:

Two workshops were organized for the project:

a. Virtual Workshop on remote sensing and geo-spatial analysis - 24-25 March 2022

b. Virtual workshop on big data and artificial intelligence for environmental monitoring and decision making - 7-8 April 2022

- Session objectives

The COVID-19 pandemic made it clear that the use of digital technologies is indispensable to foster environmental conservation and sustainable development. The objectives of both virtual workshops were:

– To promote the development of technological tools for ongoing comprehensive environmental monitoring, through the analysis of satellite imagery and systematization and analysis of data and measurements using a range of environment-appropriate instruments.

– To allow participants to share views and strengthen their capacity to address sensitive topics.

- Session activities
  Both workshops included presentations by internationally recognized experts, with time for Q&As following each session.

a. Virtual Workshop on remote sensing and geo-spatial analysis - 24-25 March 2022

- Executive summary of presentations

  - **Advances in the wall-to-wall approach of SAMOF in Mexico - Ms. Carmen Meneses, CONAFOR**

  - The objective of this session was to share with participating members of APEC economies the experience of the Mexican Forestry Commission (CONAFOR) in developing technological tools for ongoing comprehensive environment monitoring using satellite imagery analysis. To expand the space- and time-wise resolution of the vegetation cover and land use maps, as well as their accuracy, CONAFOR created the Forest Monitoring Satellite System (SAMOF).

  - SAMOF uses the SCUSV developed by INEGI to prepare land cover maps (MCS) for the base year 2016 and land cover change maps (MCC) for the periods 2000-2003, 2003-2011, 2011-2014 and 2014 -2016, with a higher spatial resolution (scale 1:75,000) and a minimum mappable unit of one hectare, as well as with greater thematic accuracy, which averages the 87% for MCSs and exceeds 90% for MCCs.

  - Preparing spatial products using the SAMOF system was a complex process comprising several stages. One critical such stage was the maps' revision and manual adjustment. The strategy to perform this task included a feedback strategy that taps exert knowledge on the economy's forest ecosystems with the support of technicians from the operational areas of CONAFOR and state governments.

  - Conafor lays the foundations to strengthen proactive transparency in the forestry sector, making available to the relevant actors in the forestry sector and to any interested person, the information obtained through the National Forestry Monitoring System and its components, such as the National Forest and Soil Inventory, the Forest Monitoring Satellite System (SAMOF) and the National Monitoring, Reporting and Verification System as public policy instruments in line with the provisions of the General Law on Sustainable Forest Development.

- Session activities included a presentation of improvements of the MAD-Mex CONAFOR software, land cover maps and land cover change maps.

➢ **Advances in the development of the Early Warning System in Mexico - Mr. Alexander Quevedo, CONAFOR**.

- The objective of this session was to share with the participants from APEC economies the experience of the Mexican Forestry Commission (CONAFOR) in creating their early warning system.

- The technology and tools to analyze data from currently available remote sensors is used to support forest monitoring across Mexico and to create a system for timely detecting coverage loss.

- Early deforestation monitoring allows authorities charged with forest resource monitoring to respond quickly to illegal deforestation practices.

- A Deforestation Early Warning System (SATD) is the result of processing satellite images (medium and high resolution) to promptly and timely identify disturbances and/or changes in forest cover. Near real-time monitoring of deforestation enables official charged with managing and monitoring forest resources to respond quickly to illegal deforestation events. In other economies, it has been shown that using this type of technology is a valuable tool to reduce deforestation.

- In this session key discussion topics were the forest disturbance detection methodology and assessment accuracy.

➢ **Transparency and availability of information for public and communities/Discussion - Mr. José Nelson Angulo, Sustainable Institute**

- The objective of this session was to share with the participants from APEC economies how they could incorporate lessons learned from the workshop to their daily tasks, so transparency, accountability and monitoring con inform decision-making regarding natural resources management projects in their respective economies.

- Session activities included a presentation of a case study on Environmental Monitoring Networks for Mining Regions in Latin America; and a discussion segment on transparency and

availability of information. Participants were encouraged to discuss/share with guest experts and other colleagues from different APEC economies their experiences and potential applications of the topics discussed to their respective economies.

- This presentation included a case study on ways environmental monitoring networks for mining regions in Latin America can support and foster effective multi-stakeholder engagement (governments, industry, academia, and communities). The case regarded the socioenvironmental issues resulting from air pollution in a small town in a mining region in the north of Colombia and how remote sensing technology was used to provide communities, governments, and industry with reliable real time data to monitor air quality and trigger policy changes for adopting better health measures, and improve monitoring, and remediation plans.

- The case underscored how remote sensing systems empowered stakeholders to set up environmental monitoring networks to foster transparency and accountability, which in turn, enabled stakeholders to make timely decisions and contribute to improved communities' quality of life and health while reducing environmental impacts and saving lives.

- In this session two key discussion topics were addressed, namely transparency best practices and availability of information to the public.

➢ **Innovation as a key factor to effect policy changes, enhance environmental protection and improve regulatory and monitoring instruments - Mr. Juan Daniel Angulo, Sustainable Institute**

- The objective of this session was to share with the participants from APEC economies how they could incorporate lessons learned from the workshop in their daily job, so innovation on remote sensing is incorporated into improved decision-making processes for natural resources management projects in their respective economies.

- The session included the following activities: a) Introduction to innovation using remote sensing technology; b) Presentation of case studies on • Differentiated Royalty • Innovative monitoring systems in tailing dams; and c) Discussion on improving regulatory and monitoring instruments and frameworks. Participants were encouraged to discuss/share with guest experts and colleagues from different APEC economies their

experiences and potential applications of the topics discussed to their respective economies.

- This session started by highlighting the top ten innovative economies and how innovation has made a positive impact in the livelihoods of their communities. It also touched on what these economies do (and how) to consistently rank among the top innovative jurisdictions worldwide. A further presentation dealt with a case study on Differentiated Royalty in the mining sector as a mechanism to foster and promote innovation among economies and how technology such as remote sensing can help cost-effectively solve environmental challenges while minimizing liabilities and assuring regulatory compliance. Finally, a second case regarding innovative monitoring systems in tailing dams showed participants how remote sensing could be used in real time monitoring of these types of infrastructure.

- The session discussed two key topics: i) improving regulatory and monitoring frameworks; and ii) real time monitoring mechanisms using remote sensing technologies.

b. Virtual workshop on big data and artificial intelligence for environmental monitoring and decision making
7-8 April 2022

- Executive summary of presentations

  - **Satellite-based sensing and computing in China - Mr. Xun Luo, China Computer Federation**

- The objective of this session was to share with the participants from APEC economies Chinas´ developments on satellite-based sensing and computing.

- The availability of satellite remote sensing data has increased significantly in the last two decades, and these data constitute a useful source for mapping and analyzing changes over time. Based on satellite remote sensing technology, China continues to standardize the regulation of sewage outfalls, and conduct ledger and inventory management of sewage outfalls entering rivers (lakes and reservoirs) in key river basins.

- Case study: From July 17, 2021, floods have ravaged Zhengzhou City, and the surrounding towns and counties. On July 25, the company launched an emergency first response to

the flood emergency in that area and engaged in remote sensing monitoring of flooded areas such as Zhengzhou, Xinxiang, Hebi, etc., comparing water covered areas before and after the disaster, and delimited the degree of disaster in the affected area.

- **Introduction of various scientific and technological approaches to improve Korea's EIA - Dr. Kim Tae Yun, Korea Environmental Institute**

- The objective of this session was to share with the participants from APEC economies how Korea developed technological approaches to improve their environmental impact assessments.

- The Ministry of Environment created its EIASS online system (EIA Support system) in operation since 2005. Developers or EIA consultants visited relevant local governments to gather baseline data from recent EIA reports through the 1990s. The baseline includes land use data, measurements, public hearing records, etc. but it was inefficient and time-consuming. EIA reports omitted protected areas, resulting in poor EIA.s An easy to use online system now provides abundant information to project owners and stakeholders from its comprehensive database. EIASS services include Disclosing documents (Draft EIA report), EIAGIS (geographic information: land use, protected areas, etc.), legislation and guideline information, current status of EIA, public hearing minutes, statistics related to EIAs, and other useful information.

- Deep learning can be trained on a huge amount of data and the results improve with more data. Also this results in high – quality predictions when compared with human source data.

- Case study: Marine environments experience continuous deterioration owing to the influx of pollutants from rivers and various infrastructure projects including breakwater construction, dredging, and reclamation. To restore marine environments, numerous mitigation plans have been established using various prediction and evaluation techniques. Nevertheless, several limitations remain: first, the ocean is a complex three-dimensional system that is difficult to model accurately; second, sea water constituents exhibit dynamic movements due to external forces such as wind, tides, currents, density, etc.; third, a significant amount of time and effort is required to observe oceanic trends; and finally, despite significant developments in marine environment prediction

technology, several assumptions and additional research area information are still required. The water quality model has been widely employed in marine environment prediction, although professional knowledge and experience, various input data, and model validation procedures are required to utilize it. However, owing to the complex and interconnected nature of marine environments, major problems such as eutrophication, harmful algal blooms (HABs), and hypoxia, are difficult to identify and solve. Consequently, considerable research has been conducted on the development of efficient and reliable prediction techniques. Since 2015, deep learning technology that makes predictions using big data has been widely used in various atmospheric, financial, medical, and scientific fields. The accuracy and applicability of the developed prediction tool is demonstrated by comparing the predicted results against the satellite data.

- Korea's presenter discussed their progress in developing a satellite-based (remote sensing) and deep learning tool. They then gathered data in a satellite and hydrodynamic model from 2015 to 2019 for the study area. The tool successfully estimated the spatial distribution of Chl-a. But additional research was needed to improve the prediction tool. Moreover, technologies like AI require gathering large amounts of high-quality data. Finally, it must be taken into account that big data and AI are global trends. Therefore, knowledge sharing between economies is needed to improve individual economy's EIA.

- Key discussion topics addressed in this session were EIA support system, remote sensing tools (satellite), and deep learning.

IV. WORKSHOP ANALYSIS

- Participants from the economies attending the events learned about:
    - The importance of remote sensing for diverse applications such as water resource management, land degradation monitoring, and air quality monitoring. They also understood the proven utility of remote sensing data in improving decision making, transparency and accountability for stakeholders across all sectors.

    - The importance of innovative remote sensing technologies for diverse applications such as real time monitoring of tailings dams.

- Advances in remote sensing satellite imaging and image processing technologies and their wide applications, as intelligent remote sensing satellites create possibilities for rapid monitoring development.

- Development of a tool using remote sensing and deep leaning. Suggestions such as collecting the greatest amount of high-quality data to support AI technology and using Big Data were made, recognizing such technologies are major emerging global trends. Therefore, knowledge sharing between economies is required to improve individual economy's EIAs.

- The rapid development of key technologies, such as remote sensing satellite platforms, imaging payload, and onboard processing systems required for the construction of the intelligent remote sensing satellite system, is transforming remote data sensing using satellites for earth observation to permit real-time perception of targets.

- To achieve time-continuous and multiangle observations of any target of interest in the world, remote sensing satellite observation programs launched by various economies are evolving from single independent remote sensing satellites to multisatellite networking and collaborative observation, real-time communication between high and low orbit satellites, convenient data receiving, and so on.

- Meanwhile, many challenges remain regarding the formulation of intelligent remote sensing satellite standards and remote sensing information regulations.

V. SET OF VOLUNTARY RECOMMENDATIONS

Finally, the following recommendations are evidenced:

- The participating economies evidenced that the lack of incorporation of adequate technology to develop automated and digital monitoring measures has repercussions on the handling of large volumes of information that, due to their characteristics (such as delivery in physical format, which prevent the direct extraction of data), makes dynamic and continuous monitoring of the variables impossible, hindering the assessment task.

- Having online information that allows dynamic monitoring and advanced or remote control of environmental variables as part of a modern and efficient system results in preventive actions and faster reactions in the event of environmental emergencies.

- Big Data is a large-scale data analysis tool, which represents an opportunity to guarantee access to information on environmental issues, helping in the process of measuring scenarios and baselines for decision making. Therefore, the availability of quality information and data is essential to monitor environmental impacts and address environmental problems and conflicts. Environmental Big Data has taken on great importance since, with data analysis, it improves decision-making capacity and the development of public policies.

- Finally, the use of technologies for remote monitoring in environmental enforcement procedures is recommended, through the approach of technological developments, which implies regulating the use of remote monitoring tools, and training inspectors to promote their use.

ANNEX I

AGENDA

Virtual Workshop on remote sensing and geo-spatial analysis

24-25 March 2022

Day 1

Session 1: Opening Session
9:00pm – 9:10pm (Peru time) / 10:00am – 10:10am (Singapore time)
Mr. Mauricio Gonzales, Project Overseer, Environmental Assessment and Enforcement Agency (OEFA), Peru

Session 2: Advances in the wall-to-wall approach of SAMOF in Mexico
9:10pm – 10:10pm (Peru time) / 10:10 am – 11:10am (Singapore time)
Ms. Carmen Meneses, CONAFOR – Mexico

Session 3: Advances in the development of the Early Warning System in Mexico
10:10pm – 11:00pm (Peru time) / 11:10 am – 12:00m (Singapore time)
Mr. Alexander Quevedo, CONAFOR – Mexico

PAUSE 10 Minutes

Session 4: Transparency and availability of information for public and communities/Discussion
11:10pm – 12:00am (Peru time) / 12:10pm – 1:00pm (Singapore time)
Mr. Jose Nelson Angulo, Sustainable Institute – Canada

Day 2

Session 1: Opening Session
9:00pm – 9:10pm (Peru time) / 10:00am – 10:10am (Singapore time)
Ms. Lily Escobar, Project Manager, Environmental Assessment and Enforcement Agency (OEFA), Peru.

Session 2: Innovation as a key factor to effect policy changes, enhance environmental protection and improve regulatory and monitoring instruments/ Discussion
09:10pm – 12:00am (Peru time) / 10:10am – 1:00pm (Singapore time)
Mr. Juan Daniel Angulo, Sustainable Institute - Canada

AGENDA

Virtual workshop on big data and artificial intelligence for environmental monitoring and decision making

7-8 April 2022

Day 1

Session 1: Opening Session
9:00pm – 9:10pm (Peru time) / 10:00am – 10:10am (Singapore time)
Mr. Mauricio Gonzales, Project Overseer, Environmental Assessment and Enforcement Agency (OEFA), Peru.

Session 2: Satellite-based sensing and computing in China
9:10pm – 11:00 pm (Peru time) / 10:10 am – 12:00am (Singapore time)
Mr. Xun Luo, China Computer Federation

Day 2

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9:00pm – 9:10pm (Peru time) / 10:00am – 10:10am (Singapore time)
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Session 2: Introduction of various technical approaches to impove Korea's EIA
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