Emerging trends on satellite-based applications in healthcare: a synoptic view

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Abstract
This study examines the state of the art and the maturity of adoption of the satellite-based applications in the healthcare domain. Moreover, it deepens the main drivers and barriers for their effective development.

Living in a more globalized, intertwined, and technologically advanced world has opened the door to a more digital healthcare system able to connect many actors, reach remote locations, and provide coverage at global level, whose exploitation has become even more urgent due the Covid-19 pandemic. Besides, space technologies may be a valid asset to tackle the future healthcare challenges. According to the United Nations Office for Outer Space Affairs, earth observation satellites, through continuous monitoring of the environment and atmosphere, may favor the identification of risk factors related to the onset of diseases in the geographical areas analyzed. Satellite telecommunications technologies can improve the use of services related to telemedicine, tele-health, tele-epidemiology and emergency management. Navigation technologies can improve the tracking of rescue routes, optimize assistance services on the territory and contribute to the location and tracking of infections in the territory. Finally, space has always been and will always be the privileged place to deepen the knowledge of the human body and the effects of protocols or interventions related to the onset of diseases in the geographical areas analyzed. The results have been then analyzed to provide a comprehensive and in-depth view of the most relevant trends. The joint combination of satellite and digital technologies appears as the enabling factor to provide an effective service to professional end users and improve quality of health for citizens. The importance of data combination from multiple satellite technologies and additional data is highlighted in many projects as fundamental to develop effective applications. Moreover, a high presence of projects has been observed in the joint domain of Earth Observation and tele-epidemiology. In this context, the possibility of combining and incorporating data from a plurality of data sources would definitely enable better epidemiology of diseases.

Method
Therefore, the framework on the relationship between space activities and global health applications elaborated by the United Nations Office for Outer Space Affairs has been adapted and populated with 86 business-cases gathered from a systematic literature review of the ESA and NASA public databases. The results have been then analyzed to provide a comprehensive and in-depth view of the most relevant trends. The joint combination of satellite and digital technologies appears as the enabling factor to provide an effective service to professional end users and improve quality of health for citizens. The importance of data combination from multiple satellite technologies and additional data is highlighted in many projects as fundamental to develop effective applications. Moreover, a high presence of projects has been observed in the joint domain of Earth Observation and tele-epidemiology. In this context, the possibility of combining and incorporating data from a plurality of data sources would definitely enable better epidemiology of diseases.

Results
Results show how multiple factors could hamper the spread and success of the emerging applications, and how those factors should inform strategic decisions to foster the development of healthcare satellite-based applications in the future. Moreover, The integration of spatial and non-spatial data and technologies appears fundamental for the development of effective services in all the healthcare domains.

To conclude, the analysis presented may be useful in promoting national and international One Health networks worldwide.

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<thead>
<tr>
<th>Factors</th>
<th>Technological</th>
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<td>Opportunities</td>
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Technological: Promoting national and international One Health networks worldwide
Economic: Promoting national and international One Health networks worldwide
Socio-cultural and organizational: Promoting national and international One Health networks worldwide
Political and legal: Promoting national and international One Health networks worldwide