15. Efficiency/productivity gains

The amount of efficiency and productivity gains derived from the use of space applications across very diverse sectors of the economy keeps growing over the years. From agriculture to energy, institutional actors and private companies are using satellite signals and imagery with positive returns as demonstrated in examples and box "How satellites are changing agricultural practices and contributing to food security". Satellites can also play a key role in providing communications infrastructure rapidly to areas lacking any ground infrastructure, contributing to link rural and isolated areas with urbanised centres (Table 15.1).

- *Positioning and navigation efficiencies*. Adoption of satellite navigation-related technologies in fishing fleets began in the mid-1980s, and general technology rollout and adoption began in the mid-1990s all over the world. Based on efficiency gains studies, the fishing power of the commercial Australian fleet increased since the uptake of GPS and plotters. The cumulative addition to fishing output that were conservatively attributed to the use of GPS plotters was estimated at 4.14% of output in 2007, equivalent to around AUD 88 million at 2007 prices (OECD, 2008).
- *Higher perspectives from space*. The specific topographic perspectives brought by earth observation and navigation satellites allow cost-efficiencies. In India, a large petrochemical group uses remote sensing to plan several pipeline routings for the transportation and distribution of natural gas/hydrocarbons. Building a geographic information system with imagery from the Indian Cartosat-1 satellite and cadastral data, the company's field work time was reduced from 90% to less than 15% from previous conventional surveys (usually only 1.5 to 2 km were covered per day compared with more than a hundred of kilometres with satellites). Updates in the imagery database will help monitor the pipeline routing areas and create long-term time series (ISRO, 2010).
- *Technology transfers from the space programme*. Many studies of "spin-offs" have been conducted in the United States since the 1960s (such as outputs from NASA's Apollo programme), focusing on the transfers from space-related hardware and know-how to other sectors (NASA, 2010). There are more than 1 600 NASA-derived technologies that have been transferred to other sectors, bringing efficiency gains particularly in medical imagery (*e.g.* Hubble telescope's optics used for increased precision in micro-invasive arthroscopic surgery).

Methodological notes

In the case of space applications, the study of productivity gains are often conducted as *ad hoc* reports, therefore methodologies may vary and render difficult international comparability. The OECD is building up a database of existing indicators, as to provide access to data and methodological information.

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How satellites are changing agricultural practices and contributing to food security

As many countries seek to ensure self-sufficiency in production of selected commodities, satellite data often represent a good option to complement or even replace ground monitoring systems, which are not easily deployable or too expensive to set up.

- *Near real time products*. Users, whether policy-makers, farmers or researchers, can find today a range of near real time products providing information on vegetation and land use, particularly on what types of crops are being planted nationally and around the world (*e.g.* 3 hour latency for NASA-MODIS products on soil moisture for example).
- *Improved cadastral information*. In many countries there is a growing need for governments and farmers to better map their arable land. In India, the Ministry of Rural Development is leading the "National Land Records Modernization Programme", which aims to check private cadastral information and improve land-use planning nationally. It relies on data from the dozen or so Indian remote sensing satellites. In Europe, the Common Agriculture Policy provides direct aid to farmers, with amounts distributed in part per declared square metre of land. European Commission inspectors are using commercial precision farming products, positioning and remote sensing data, to check whether the area declared by farmers is eligible.
- *Increasing cost efficiencies*. Although precision agriculture remains a niche market, many farmers in several OECD countries (*e.g.* Canada, France, the United States) have started using devices with GPS signals and satellite imagery for the entire agriculture cycle: planning (surveying their fields and crop varieties); planting (making sure the planting is done on straight lines); crop protection (spaying insecticides, fertilisers per square metre) and harvesting (helping enhance crop yields by making sure farming machines follow straight lines). Reduction of fertilisers and pesticides is one of the key benefits of using precision agriculture.
- *Better irrigation practices*. Adequate irrigation is essential to improve food productivity in many regions, especially as fresh water is becoming scarcer. In India, under the "Rajiv Gandhi National Drinking Water Mission" of Ministry of Rural Development, remote sensing technology is already used for preparing groundwater maps in ten states. The success rate of bore wells is already around 90% in most States. The project is now being extended in phases to cover the entire country.

15.1 Space applications providing unique societal services

	Key facts	Space applications bringing societal services
Indonesia	Inhabitants: 271.4 million. The territory constitutes of 17 000 islands in three time zones.	Tele-education: the Indonesian palapa satellite system provides tele-education programmes via television broadcasts. With the launch of the latest Palapa satellite, the 2011 target is to provide increased access for approximately 43 000 rural villages.
India	Inhabitants: 1.144 million, nearly 700 million live in 600 000 villages.	• Tele-education: The dedicated Indian Edusat satellite permits to reach 55 000 virtual classrooms, allowing two-way communications in many cases. • Telemedecine: the Indian fleet of telecommunications satellites, the Insat network, connected already 382 medical facilities in June 2010 (306 district/rural hospitals, 60 specialty hospitals, 16 mobile units).
Thailand	Inhabitants: 67.7 million.	Tele-education: Thai education programmes are transmitted via the second generation Thaicom satellite systems to some 3 000 secondary schools and 7 000 primary schools in Thailand.

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