

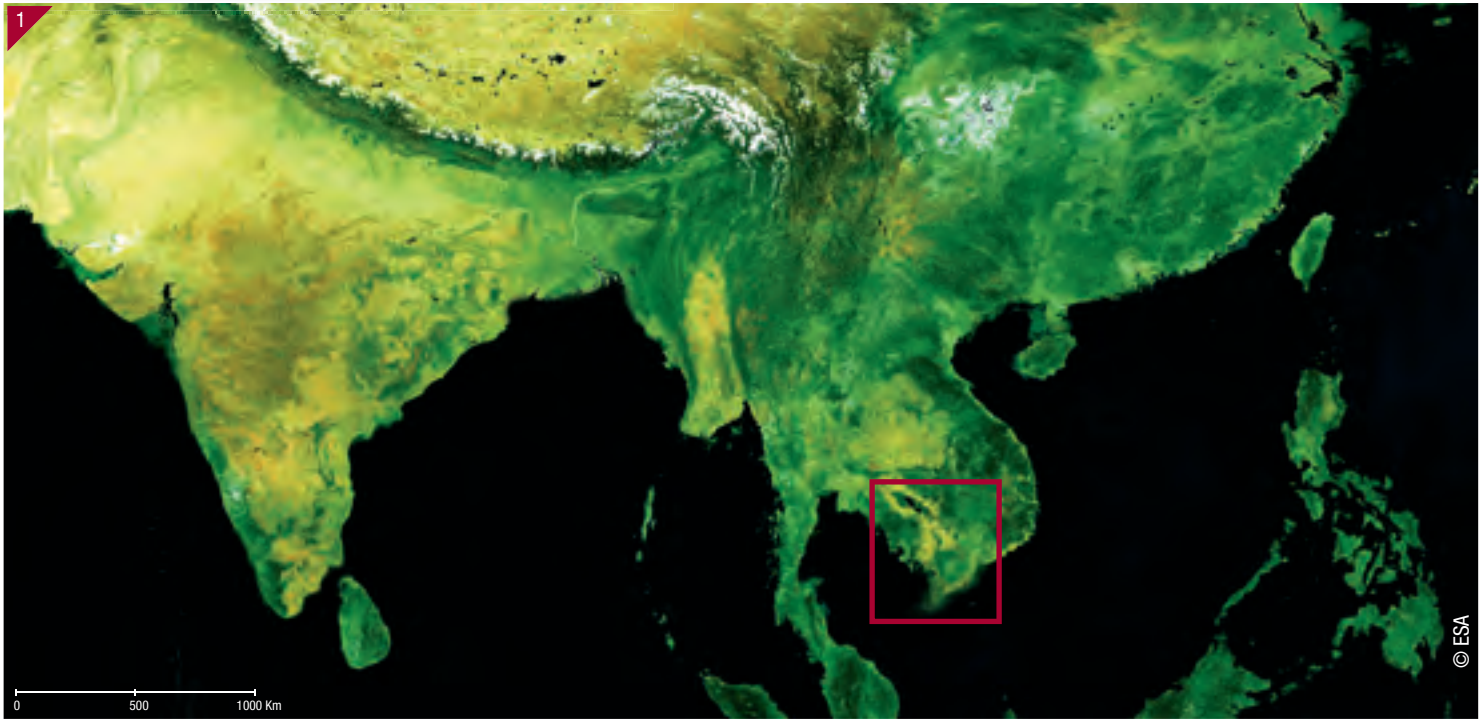


© ESA

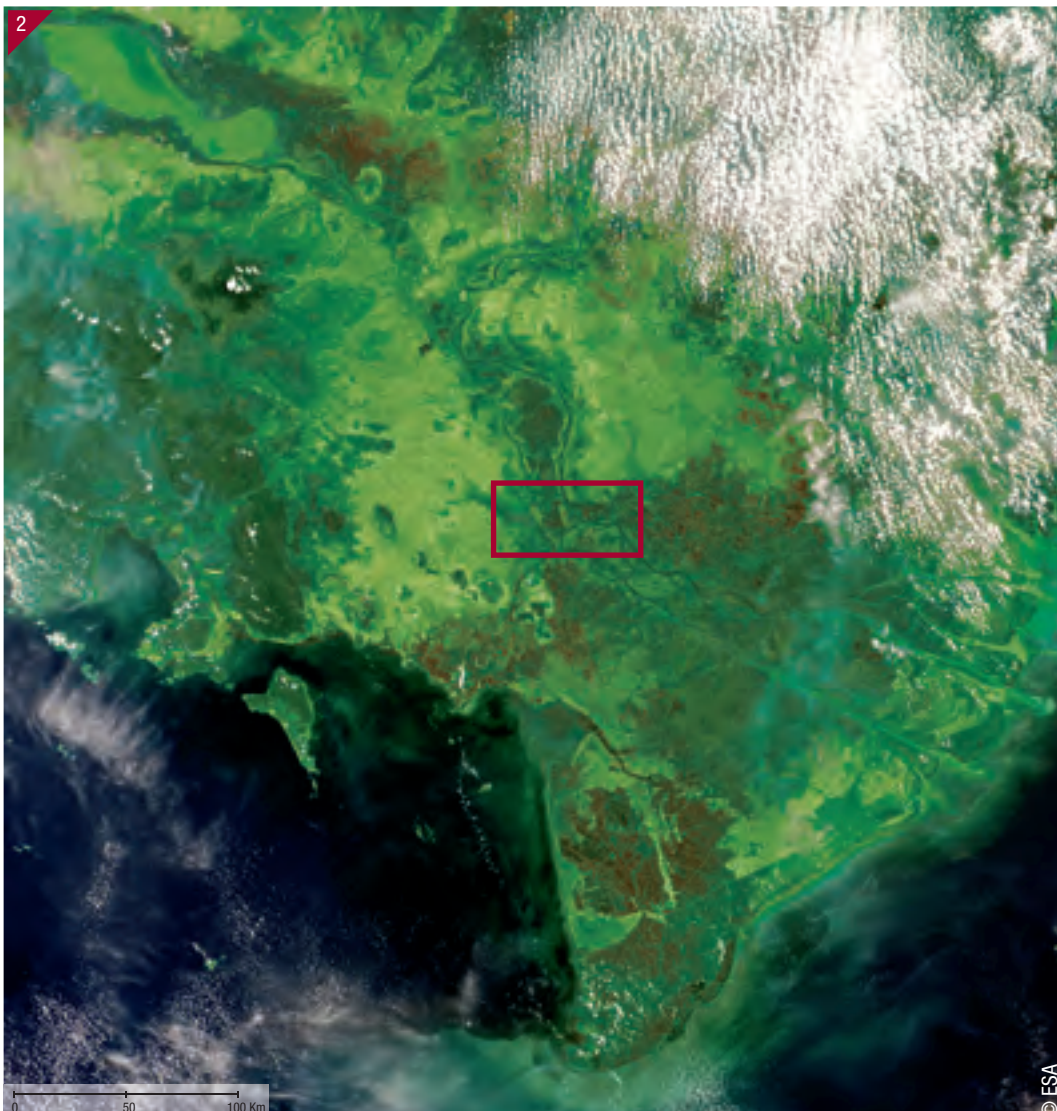
5- Asia and rice-growing



RICE-GROWING IN MONSOON-AFFECTED ASIA



The Mekong river takes its source in the Himalayas. It flows into the sea near Ho Chi Minh City in Vietnam after crossing and irrigating several countries including China, Myanmar, Laos and Cambodia along the way.



The Mekong delta in Vietnam. Each year the delta reclaims several metres from the sea thanks to the enormous volumes of sediment it transports.

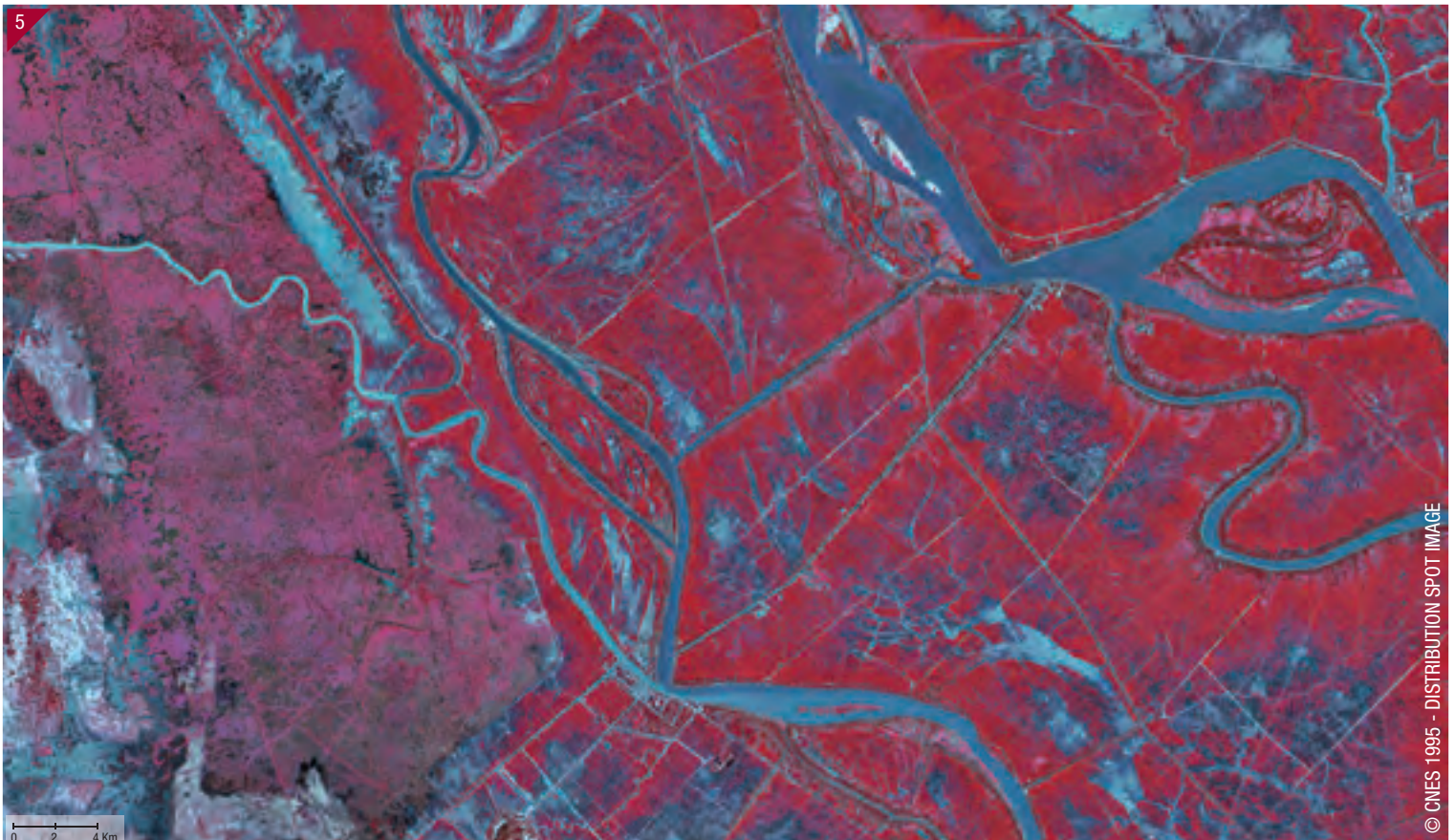
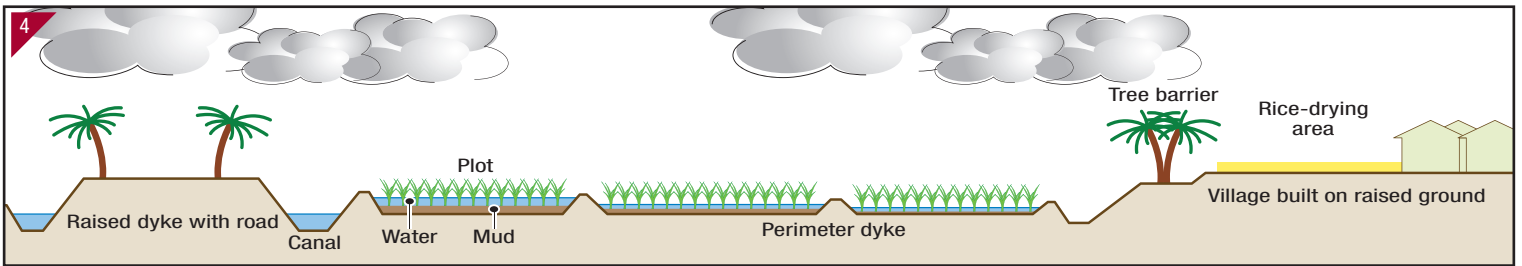
Rice is one of the most important food crops in the world. 91% of the world's rice is produced in Asia and the Pacific region. In the coming years, the demand for rice is set to grow constantly to meet the needs of populations. By 2025, Asia will have to have doubled its current production of 490 million tonnes.

Rice-growing requires a great deal of water and is therefore something to which the hot and humid climate of South East Asia is well-suited. The most fertile land is to be found on the plains, along rivers and in sediment-rich areas such as the Mekong delta.



© MICHAEL WABEL

Aerial view of rice fields in the Mekong delta.



© CNES 1995 - DISTRIBUTION SPOT IMAGE

Satellite image of rice-growing areas in the Mekong delta taken by SPOT 5. This is a composite view produced by combining several images from different sensors including an infrared sensor that shows vegetation in red.



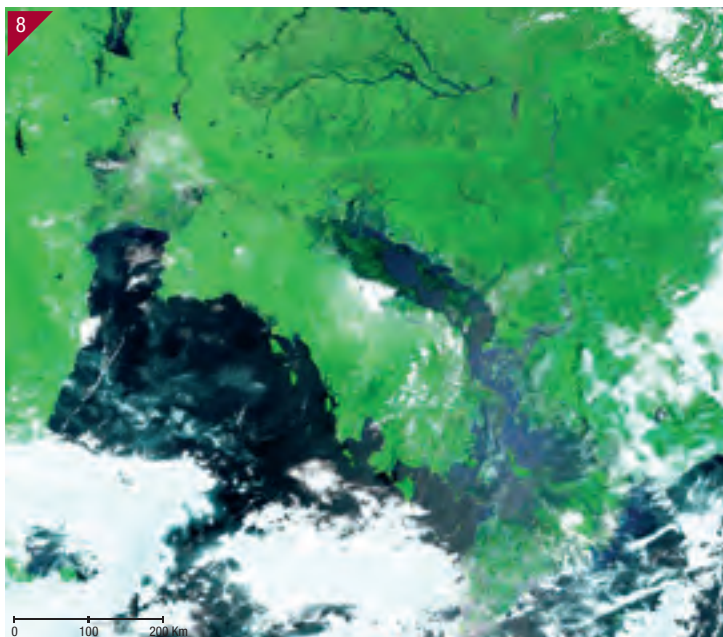
Villagers transplanting rice.

Rice grows in a blanket of water, the level of which rises as the plant grows. In the Mekong delta, it is mainly cultivated on low-lying plains, where some of the river water can be diverted by canals to irrigate the fields.

The heavy precipitation during the monsoon provides the vast quantities of water needed for rice-growing. Irrigation systems serve to control rain and river water with the result that it is possible to have one or two more harvests in the year.

EFFECTS OF THE MONSOON

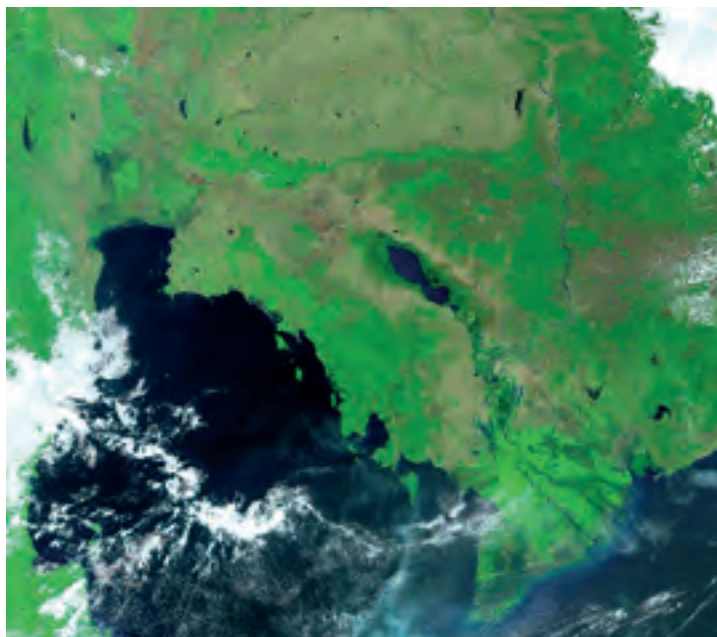
Rice-growing requires a hot and humid climate and is therefore something for which the monsoon climate predominant in South-East Asia is ideally suited. On the Cambodian plains, the Mekong's rate of flow is 15,000 m³ per second during the dry season, reaching 65,000 m³ per second during the rainy season. The flooding visible in the left-hand image extends over more than 20,000 km².



In the left-hand satellite image, taken during the rainy season, the flooded areas around the Mekong river are clearly visible.



In Vietnam, the most densely-populated regions are the coastal zones and the Red River and Mekong deltas.



CROP MANAGEMENT

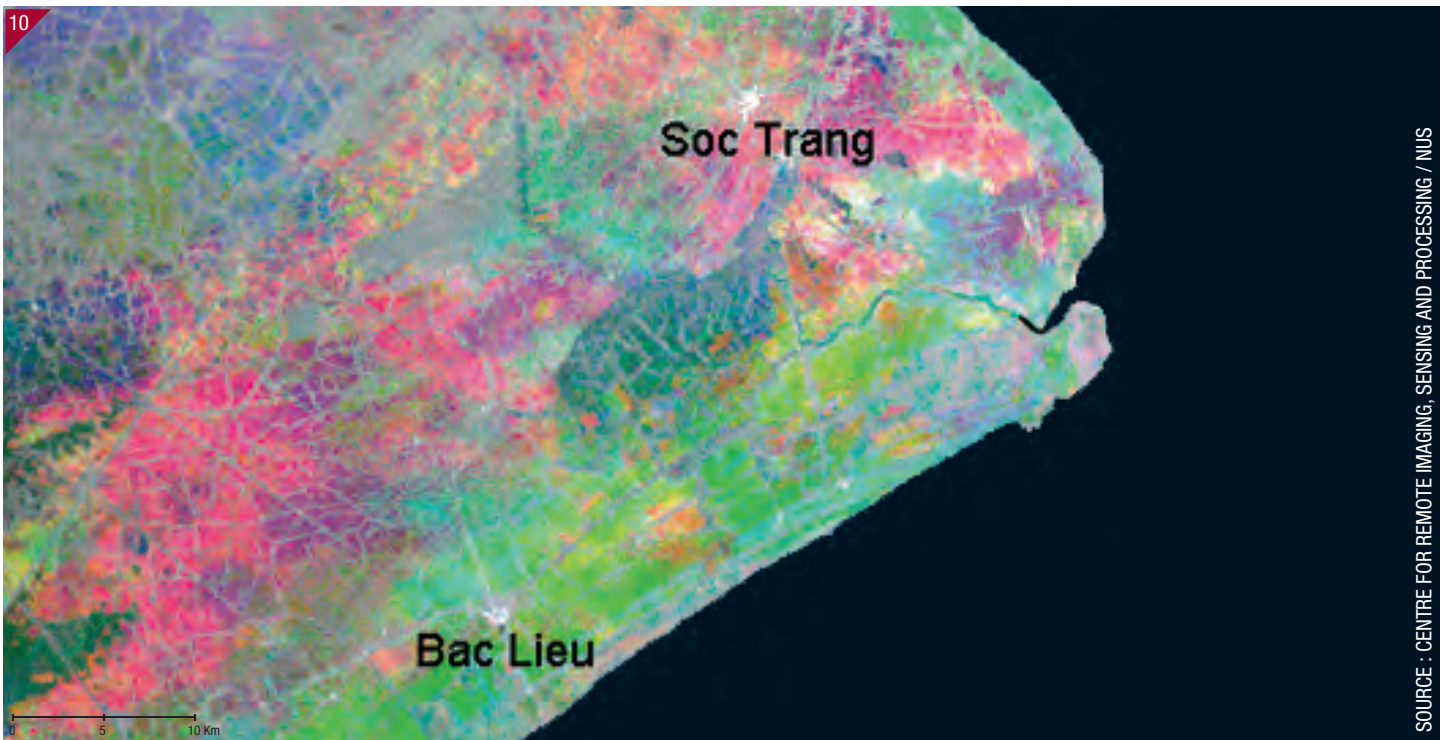


The Mekong delta in Vietnam

All rice-producing countries need precise and constantly updated information on the state of their rice fields and the growth of their rice crop. The aim is to plant as early as possible in the season those varieties which are best suited to conditions in order to obtain optimum use of the land.

Such information is difficult to obtain through the traditional method of monitoring by farmers or specialists on the ground, which is costly, imprecise and difficult to carry out on a widespread basis. In contrast, satellite remote sensing techniques (using radar able to penetrate cloud cover) make it possible to conduct regular analysis of rice fields and thus provide precise information on rice growth and on the entire irrigation system.

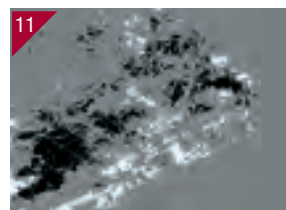
Radar images give precise information on the various stages of the rice-growing process from one region to the next. They can be used to determine what varieties are being used and where. By merging several images taken at different times, each of which is assigned a different primary colour, it is possible to show areas where one, two or three crops are harvested each year.



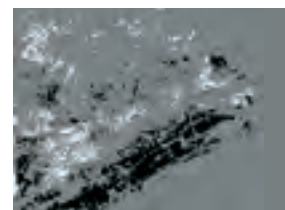
The Soc Trang and Bac Lieu regions in the Mekong delta.

The above colour image was obtained from black and white radar images, each taken in a different week. The grey areas are those where the radar signal remained constant between the two measurements. Black indicates that the signal has faded and white that it has intensified. Thus, it is possible to gauge precisely the stage of growth reached by the plants in each individual rice field and then create a colour image showing the exact characteristics of the rice fields in a particular area.

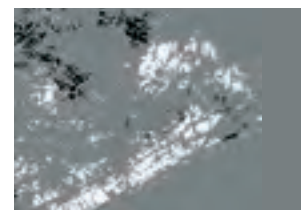
Each of the pictures to the right compares the differences in signal between 2 dates.



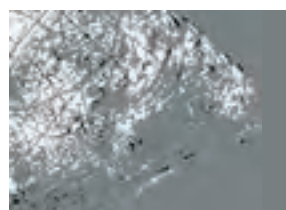
5 May / 9 June



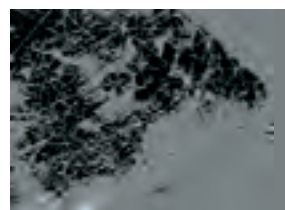
9 June / 14 July



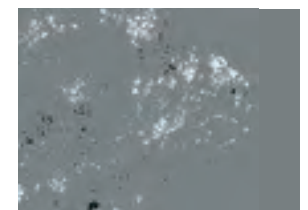
14 July / 18 August



18 August / 22 September



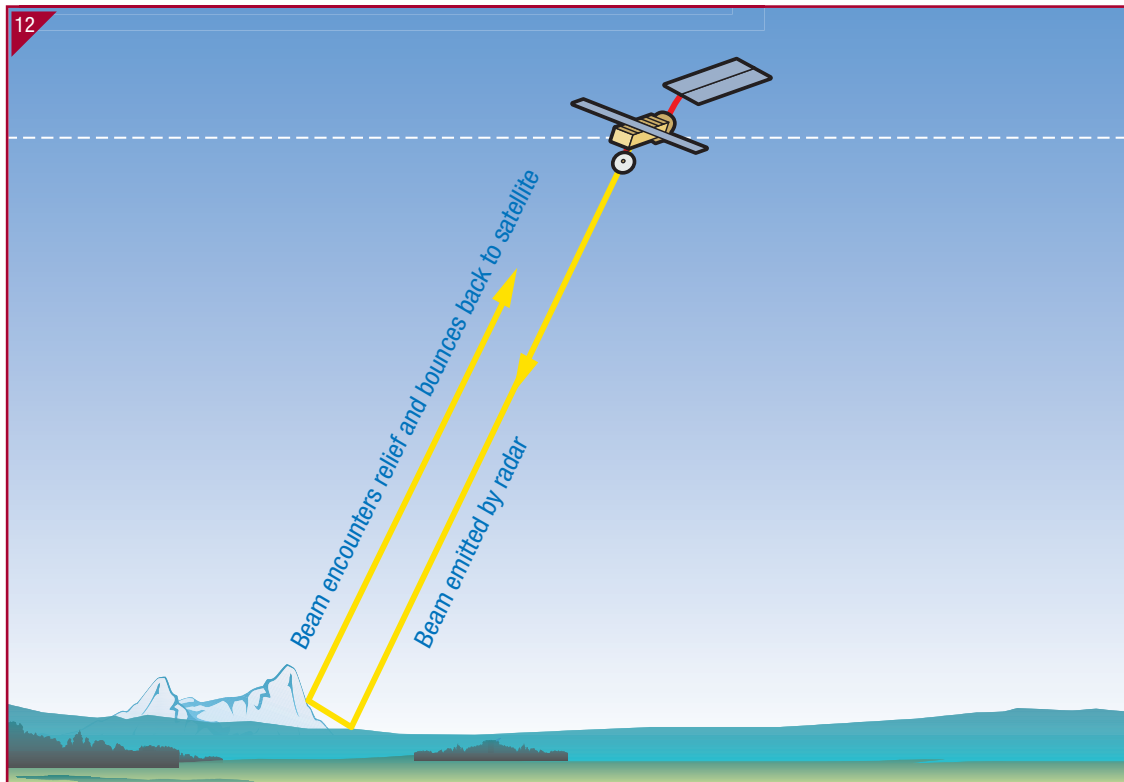
22 September / 27 October



27 October / 1 December

How do satellites work?

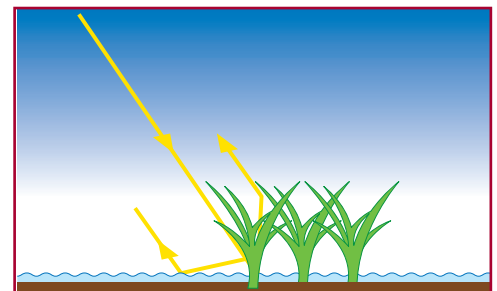
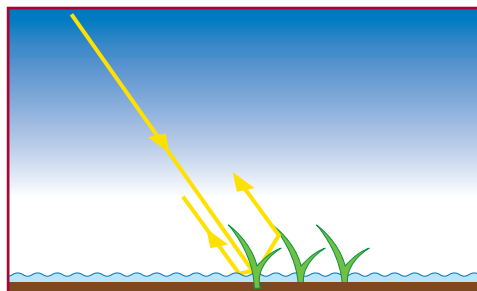
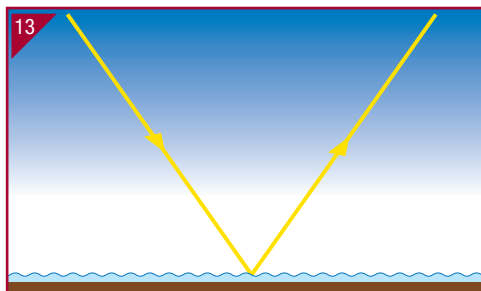
The principles of radar imaging



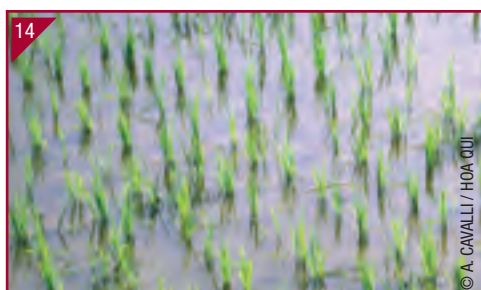
Radar instruments do not measure sunlight reflected by the Earth. Instead they detect the echo of a signal that they themselves send out, which then bounces back off the obstacle encountered. Depending on the nature of the ground, the signal bounces back with varying intensity. By recording these variations, radar instruments are able to build up a relief image.

How radar signals measure rice growth

A great deal is known about the growth cycle of rice. It is made up of very precise stages, beginning with the appearance of the first shoots in the flooded rice fields, after which the plant flowers and panicles appear. After the harvest, the soil in the fields is laid bare and dries out, at which point a new cycle can begin. At each stage in the cycle the fields display very different characteristics which satellite radar instruments can measure with great precision.



The signal level measured by radar corresponds to the various periods of rice growth: in the first phase, the water and the flooded fields send back a very weak signal, while subsequently the response level intensifies in direct proportion to the plant's development.



Information for teachers

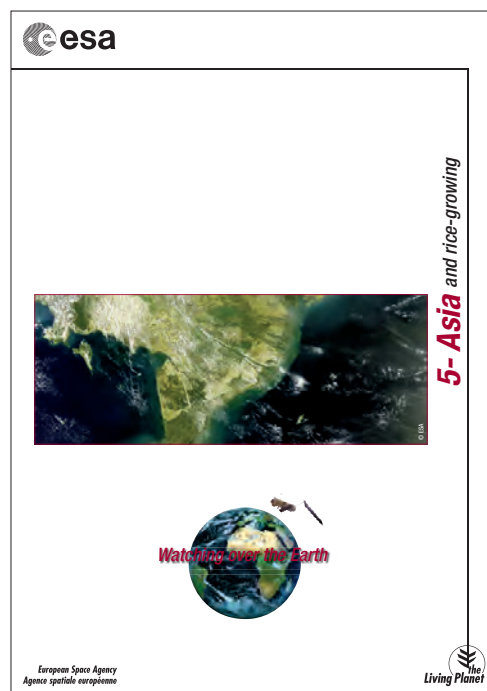
The “Information for teachers” sheets are designed to offer assistance with the preparation of classes and complement the worksheets handed out to pupils. They contain useful information for the presentation of the subject, additional information relating to the satellite images, and a list of websites dealing with the subjects concerned.

Worksheet 5: Asia and rice-growing

Worksheet 5 examines rice-growing in Asia. Geographically it focuses on rice-growing in the Mekong delta in Vietnam. As a crop, rice has extensively contributed to the high population density on this continent, which accounts for 3 of the 4 global regions with the highest population density (East Asia – 1.5 billion inhabitants, Southeast Asia - 580 million inhabitants, South Asia - 1.3 billion inhabitants).

This worksheet can be used to:

- observe and identify, with the help of different types of documents, the shapes and landscapes inherent to rice-growing;
- draw connections between the foundations of an agrarian civilisation, a “natural” phenomenon (the monsoon season), and high population density;
- identify the major rice-growing deltas and work with different scales using various documents provided;
- apply concepts such as agrarian civilisation, monsoon, density, nourishing river, rice-growing, etc.



Rice-growing in Asia's monsoon areas

Rice is more than “just another grain”. Throughout Asia, it has played a role in the region’s civilisations. Rice is the leading cereal produced for human consumption. It is the staple food for all the societies living on the vast Asian continent. It is grown in tropical regions, in particular in the deltas of major rivers which flow down from the Himalayas, such as the Mekong, Song Ho, Chao Phraya, and Irrawaddy rivers. Rice is also grown in mountainous regions with abundant rainfall. Rice is special not only because of its nutritional qualities—the straw from the rice plant is used as fuel, manure, to make ropes, bags, hats, etc. For a long time, rice was used in place of currency. It has had both economic and social implications: the need to control water and irrigation systems brought about a very complex pyramidal social structure.

Rice is also considered to contribute to population growth as it is extremely labour intensive and determines which regions will have high population density. Lastly, rice-growing creates orderly landscapes designed to accommodate dikes, canals, gates, etc.

Rice is a demanding plant, which needs to grow in temperatures of at least 20°C over three months, uses 30,000 m³ of water per hectare, and requires special seedling planting techniques following 50 days in nurseries. The monsoon climate is perfectly suited to growing rice.

In 2003, 9 out of 10 leading rice-growing countries in the world were in Asia: China (166 MT), India (115 MT), Indonesia (52 MT), Bangladesh (38 MT), Vietnam (35 MT), Thailand (27 MT), Myanmar (22 MT), the Philippines (13 MT) and Japan (10 MT), together accounting for 90% of global rice production. Paradoxically, rice is the least traded grain in the world (barely 3% of all rice produced is exported), which shows its role in making Asian countries with monsoon climates self-sufficient in terms of food production. Thanks to improved crop yields, Thailand has become the world’s leading exporter of rice (30% of total volume at nearly 6 MT).

The satellite images

Cover page

Cover image: Mekong Delta

In this satellite image, one can easily see where the silt has been deposited by the river. The formation of the Delta is continuing apace and it is progressing into the South China Sea at a rate of approximately 75 metres per year. Meanwhile, the eastern coastline of the southern part of the Delta is subject to severe erosion, which may be connected to a recent reduction in deposits on the coast or to marine encroachment (see also image 2).

Core content

Image 1: South-East Asia (ESA/Envisat, 2004)

This image shows the Himalayan mountain range, which constitutes a vast reservoir of water feeding the rivers of the region. In this image oceans and seas are in black because the data acquired from these marine territories have not been taken into account. There are no clouds because the image is a composite of multiple partial views taken at different periods when the sky was clear.

Image 2: The Mekong Delta (ESA/Envisat image)

In this close-up of the Delta, it is possible to make out the arms of the river and the cloud cover present at the time of capture. One can also see the silt which has been expelled into the sea. The green area in the centre is a more humid zone where vegetation is more highly developed.

Image 5: Rice fields in the Mekong Delta (Spot 5 image)

Vegetation reflects not only in the green band but also in the near infrared, notably when photosynthesis is very active. The use of this band is therefore a highly effective means of spotting vegetation and highlighting variations in it.

By convention, the near infrared channel is represented in red in these satellite images. To obtain an image in natural colours requires digital processing, which restores the green colour to these areas. (Worksheet N° 6, "Humans on Earth" and Worksheet N° 11, "Satellite images and their colours" also deal with these questions)

Abundant vegetation can be seen in the humid areas close to the river as can the irrigation canals taking water to areas further away. Certain fields, in blue, indicate rice fields in which the rice has not grown to a significant size, and thus shows variations in the speed of rice growth.

Image 8: Effects of the monsoon (Image by MODIS/NASA GSFC)

These two pictures taken in October 2002 (during rainy season) and in January 2003 (in the dry season) show the size of the Tonle Sap great lake, which declines from more than 12,000 km² to just a few hundred square kilometres, and in depth from 10 to 2 metres (Image from the "Rapid Response Team", based on MODIS data).

Page 5 - Crop management

It is important to emphasise the role played by radar instruments, which enable the production of images in a region where there is frequent and substantial cloud cover. It is mainly this type of image that is used by scientists to conduct detailed observation of the state of rice fields.

Image 10: Mekong Delta coastal area (ERS-2 – SAR)

This "multitemporal" image is formed from a series of images acquired by the European Space Agency's ERS-2 satellite's radar instrument. It makes it possible to differentiate between the various rice-growing areas in the western part of the Delta.

The image was created by combining radar captures performed at different times, each of which is attributed a different colour, according to an agreed code: (5 May = red / 9 June = green / 14 July = blue). Each colour indicates a time and place at which the rice plants reached maturity. A single image of this type is therefore able to provide specialists with comprehensive information, zone by zone, on the various rice varieties planted, but also on productivity and irrigation quality.

Image 11: Series of radar images of the Mekong Delta coastal area (ERS-2 – SAR)

These six black and white thumbnails were combined to form colour image 10. Each thumbnail shows the increase and decrease in the intensity of the radar signal over a given time. Such images require that several acquisitions of data are performed at precise dates.

Page 6 – "How do satellites work?"

The aim of this page is to explain the principle of radar instruments on satellites.

Image 12: The principles of radar imaging

There are two main sensor types used in remote sensing satellites: passive and active sensors. Passive sensors detect rays emitted directly by the Earth, such as thermal infrared rays or waves reflected by the Earth's surface (sunlight). Active sensors detect the echo from a signal (in the form of microwaves) which they themselves have sent. This is how radar instruments operate.

Thus, for each target that receives the wave emitted by the radar there is a corresponding "echo", which is of varying intensity and which returns more or less quickly. The amplitude of the reflected signal is measured to discern different targets, and the delay between the transmission and reception of the signal is used to determine the target distance.

Images 13, 14, 15 and 16: Radar signals to measure rice growth

Radar waves are just as sensitive to relief as to the ruggedness of terrain and its humidity. Radar is therefore as effective at detecting a mountain or vegetation cover as it is an expanse of water owing to their distinct echoes.

RICE-GROWING IN MONSOON-AFFECTED ASIA

The Mekong River takes its source in the Himalayas. It flows into the sea near the city of Ho Chi Minh City in Vietnam after obtaining and irrigating several countries including China, Myanmar, Laos and Cambodia along the way.

Rice is one of the most important food crops in the world. 31% of the world's rice is produced in Asia and the Pacific region. In the coming years, the demand for rice is set to grow constantly to meet the needs of populations. By 2025, Asia will have to meet double its current production of 450 million tonnes.

Rice growing requires a great deal of water and is therefore something to which the hot and humid climate of South East Asia is well-suited. The most fertile land to be found on the plains, along rivers and in sediment-rich areas such as the Mekong delta.

The Mekong delta in Vietnam. Each year the delta sustains several million from the sea thanks to the enormous volume of sediment it transports.

View from the sky of the fields in the Mekong delta.

Rice is grown in a basket of water: the level of which rises as the plant grows. In the Mekong delta, it is usually cultivated on low-lying plains, where some of the river water can be diverted by canals to irrigate the fields.

The heavy precipitation during the monsoon provides the vast quantities of water needed for rice-growing. Irrigation systems serve to control rain and river water with the result that it is possible to have one or two more harvests in the year.

EFFECTS OF THE MONSOON

Rice growing requires a hot and humid climate and is therefore something for which the monsoon climate predominant in South-East Asia is ideally suited. On the Cambodian plains, the Mekong rate of flow is 13,000 m³ per second during the dry season, reaching 65,000 m³ per second during the rainy season. The flooding visible in the left-hand image extends over more than 20,000 km².

In Vietnam, the most densely populated regions are the coastal areas and the Red River and Mekong deltas.

In the left-hand satellite image, taken during the rainy season, the flooded areas around the Mekong river are clearly visible.

Online resources

www.esa.int
www.esa.int/SPECIALS/ESRIN_SITE/index.html

www.esa.int/eo
earth.esa.int/earthimages
www.esa.int/education
www.eduspace.esa.int
www.cnes.fr

www.cnes-edu.fr
www.spotimage.fr

ESA (European Space Agency) website
ESRIN (European Space Research Institute) website
ESRIN is ESA's centre for Earth observation
ESA Earth observation website
Gallery of ESA satellite imagery
ESA educational website
Earth observation educational website (EDUSPACE)
CNES (Centre National d'Etudes Spatiales) website
Presentation of the French national space agency's missions and activities
CNES educational website
SPOT IMAGE gallery

RICE-GROWING

www.unctad.org/infocomm/anglais/rice/crop.htm

www.fao.org/rice2004/en/aboutrice.htm
www.eomd.esa.int/booklets/booklet185.asp

Information on rice farming.
UNCTAD website. (United Nations Conference on Trade and Development)
FAO (UN Food & Agriculture Organization) website. Information on rice growing
ESA information on rice growing and remote sensing

MONSOONS

www.metoffice.gov.uk/education/secondary/students/monsoons.html

Met Office information on monsoons

Satellite images



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Europimages - Alette Cremer

Worksheet N° 5 – Asia and rice-growing

Once you have read and carefully examined the worksheet, please answer the following questions :

1 – In what part of the world is rice-growing most widespread? For what purpose is the rice grown?

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2 – What is special about this grain? What does it need in large quantity?

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3 – What is the name of the unusual climatic event that happens in this part of the world? What does it bring?

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4 – Look at and describe the landscapes shown in the two photographs ((images 3 and 6). How can you tell that rice-growing requires a lot of hard work?

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5 – Look carefully at the map of Vietnam. Where are the most densely-populated regions? Why?

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6 – How can satellite images be useful for rice growers?

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7 – What is the name of the instrument placed on-board satellites which helps observe the relief and the different growth stages of the rice plants in the rice fields? What exactly does this instrument detect?

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