Global Health Security
--- Space medicine and satellite technology for public health ---

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Topics

1. Space medicine
   • Human space flight technology for people on Earth
     • Health care on individual level

2. Satellite technology for public health
   • Satellite data for health issue
     • Health care for public use
       --- Tele-epidemiology ---
     • WHO in the area of Polio eradication
Human space flight technology enables us to live safer and more productively.

Exploration continues to Moon, Mars and beyond.

6-month to 1-year stay in ISS

Pioneers of human space exploration:

Yuri Gagarin
The first human in space

Valentina Tereshkova
The first woman in space

Koich Wakata
Working and living in ISS
Space environment and its health risks

International Space Station (450 km above the earth)

Environment:
1. Microgravity
   • Balance disorders
   • Cardiovascular deconditioning
   • Decrease of bone mineralization
   • Muscle-disuse atrophy
2. Closed, confined, multi-cultural environment
   • Mental stress
   • Depression
   • Reduction in group dynamics
3. Cosmic radiation
   • Cancer risk
   • Reduction of immune response

The space environment can affect health
Space medicine is for ensuring the health of people living and working in space
Area of JAXA Space Biomedical Research

Physiological countermeasures
- Bone and Muscle
- Cardiovascular System

Psychological support
- Stress Management

International Space Station (ISS)

Medical systems
- Devices
- Communication system

Environment of spacecraft
- Off Gases (Emitted gases)
- Micro-organisms

Moon-base frontier medicine

Cosmic radiation
ISS: Space life science research for humankind

Health and mental care for people living in space
Stepping stone for human exploration to the Moon, Mars and beyond

Benefits for people living on Earth

In space
- Health and mental care
- Exploration beyond the ISS

On earth
- Health education
- Mission X "Train like an Astronaut"
- Pamphlet for senior citizens

Food Safety
Tele-medicine
Environmental monitoring
Eco-system

ISS promotes integrated human research for benefits on Earth and in space
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Concept of using satellite technology as a medical tool
------ Public Healthcare ------

Environmental information helps health care on public-level

**Space medicine**
Health care on Individual basis for Astronauts
- for people on Earth

**Satellite technology**
1. Communication
2. Earth observation
   1. Monitor
   2. Assessment
   3. Prediction, Prevention

**Benefits from space for public health**
Health care on public-level
- Dedication of space technology
  - Earth observation
  - Human health
  - Education

ISS
Shizuku (GCOM-W1)
Ibuki (GOSAT)
Satellite data for health issues

Air quality and aerosol mapping
- Air pollution (PM, Ozone, NO\textsubscript{x}, SO\textsubscript{x}, etc.)
- Aerosol Asian dust (Kosa)
- Green House Gas (GHG)

Vector’s habitat/transmission route characterization and mapping
- Land surface Temperature
- Precipitation
- NDVI (Normalized Difference Vegetation Index)
- Sea surface Temperature Ocean color

LULCC, DEM
Geographic Information System (GIS as base map)
Dust from the Asian continent

- 2.2% increase in mortality rate of senior citizens when Asian dust flies in spring
- The rate of hospital admissions and out-patients increased in respiratory, circulatory, and ophthalmology departments

Korean Epidemiological surveillance from 1995 to 1998
Source: Ministry of the Environment, Government of Japan
JMA’s activities on Asian dust

Aeolian dust observation

Aeolian dust prediction

Japanese only

Number of Kosa observations

Basic information of Kosa

http://www.jma.go.jp/jp/kosa/

General weather information of Kosa (when needed)

JMA has been providing Aeolian dust information since January 2004.
MRI has been developing the numerical dust aerosol model.
Heat wave in Europe, Aug. 2003

**Left:** Atmospheric temperature deviation in Aug. 2003 from 2002 derived from AMSR-E. Some spots are supposed to be false patterns due to radio interference.

**Right:** Sea surface temperature deviation in Aug. 2003 from 2002 derived from MODIS.

**Deaths (heatstroke and excess mortality) from Europe’s 2003 heat waves:**

22,146 in Europe (14,802 in France and 3,134 in Italy)

Sources: WHO, 2004 report

Quoted Heat waves fact at a glance: www.ifrc.org/publicat/wdr2004/chapter2.asp
Danger area of tropical malaria in Indochina peninsula
Estimated from NOAA/AVHRR images

Map of duration in month with NDVI (Normalized Difference Vegetation Index) higher than 0.4 estimated from Vegetation Index Mosaic in 1977, East Asia (NIES)

Satellite data can be used for tracking and predicting malaria outbreaks

Analysis of Malaria Endemic Areas on the Indochina Peninsula Using Remote Sensing
Naoko Nihei, Mutsuo Kobayashi et al.
JPN.J.Infect.DIS.,55, 160-166,2002
Cyclone "NARGIS" reached Myanmar on May 2-3 2008
Flooding along Ayeyarwaddy River

WHO Report on May 29th 2008
http://www.searo.who.int/en/Section10/Section2535.htm#May29

Cyclone Nargis and communicable diseases
On day 26 of cyclone:
• 77,738 people dead
• 55,917 people missing
• Cases of diarrhea and dengue fever are being investigated
• Along with water-borne diseases, vector-borne diseases and acute respiratory infections (ARIs) remain a concern as these cases are expected to increase in the rainy season

Precipitation information from satellite data can be used for disease control
Polio still remains in developing countries where hygienic sewage systems are underdeveloped. 
- Pakistan, Afghanistan, Nigeria, Somalia, Guinea, Iraq, Cameroon, Syria, and Ethiopia.

The status of propagation, reinfection, and efficacy of countermeasures can be monitored by detecting the Polio virus from water samples in sewages.

WHO needs to know from where they should collect water samples in wide-range and remote areas.
JAXA operated ALOS from 2006 to 2011.

- Optical and radar sensors
- Observation from 3 dimensions using an optical sensor for 3D View
- Global observation (all countries)
- Spatial resolution: 2.5m
3-D View of the Earth developed using Digital Elevation Model (DEM) and Imagery from ALOS

Asian region is now available.

Whole globe will be available by March 2016.


- The world’s best precision of 5m in spatial resolution with 5m both vertical and horizontal accuracy.
- 30m-spatial resolution DEM will be freely-available 6 months after the 5m version.
JAXA and RESTEC* used the 3-D View of ALOS.

Purple: Catchment Area
Blue: Flow path
Red: Pour Point (Possible sampling point)

* Remote Sensing Technology Center of Japan
JAXA technology revealed more accurate catchment areas

(A) Analysis by Gates Foundation and ESRI using 30 m-resolution DEM

(B) Analysis by RESTEC using 5 m-resolution DEM

Catchment area of B is wider than yellow-lined A by 5 times
- WHO signed RESTEC to a contract to conduct analysis in 3 cities of Niger.

- WHO decided sampling points using the analysis.

- WHO evaluated the analysis, a very useful tool especially in flat areas, and in complicated landforms.
Summary

“Bringing the benefits of space to Earth” has been promoted by human space flight technology including space medicine

Space technology is very effective for monitoring the environment, because it provides:

- wide range of observation
- communication links

Global health security can be promoted through space technology