Challenges for Science Interface to Society

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INDIAN NATIONAL SCIENCE ACADEMY
NEW DELHI
JUNE 8, 2012
## India: Key Social and Economic Issues

<table>
<thead>
<tr>
<th>Development Goals</th>
<th>Key Issues</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Education</strong></td>
<td>Achieve 100% literacy; Increase Teachers &amp; Infrastructure; Enhance Vocational skills; Higher education and research</td>
</tr>
<tr>
<td><strong>Improve Health Systems</strong></td>
<td>Reduce Child Mortality; Improve Maternal Health; Life-style health improvement; Hygiene; Access to health-care systems; Traditional medicine; Immunisation; Nutritional Security</td>
</tr>
<tr>
<td><strong>Eradicating extreme poverty &amp; hunger</strong></td>
<td>Increased agricultural productivity; Food distribution and Nutrition availability; Increase Income generation</td>
</tr>
<tr>
<td><strong>Ensuring environment sustainability</strong></td>
<td>Land and water management; Sustainability of development; Green Cover increase; Pollution control</td>
</tr>
<tr>
<td><strong>Energy security</strong></td>
<td>Reduce dependence on oil; Alternate energy from solar, wind etc;</td>
</tr>
<tr>
<td><strong>Sanitation and Waste Management</strong></td>
<td>Increase Access to sanitation; Waste management and treatment; Non-potable Use of Recycled water</td>
</tr>
<tr>
<td><strong>Disaster Management</strong></td>
<td>Ability to predict disaster; Disaster Preparedness systems; Building Resilience to Disasters</td>
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</table>

### Population
- 1.2 Billion
- 17.5% of global population
- 50% < 25 years age

### Resources
- 140 mha arable land
- 24% forest cover
- 420 mham water
- Rich biodiversity

### How S&T can meet the challenges
- [Insert text here]
## S&T AGENCIES: CONTRIBUTION FOR SOCIETAL DEVELOPMENT

<table>
<thead>
<tr>
<th>Development Goals</th>
<th>S&amp;T AGENCIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Education</td>
<td>All scientific Departments</td>
</tr>
<tr>
<td>Improve Health Systems</td>
<td>ICMR, DRDO, DAE, SPACE, CSIR, DBT</td>
</tr>
<tr>
<td>Eradicating extreme poverty &amp; hunger</td>
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India’s Vision for Science

• **Scientific knowledge should strongly contribute** for economic prosperity and for building a far more inclusive society, with the bulk of India’s population gaining access to facilities for education and health care and living a life with hope and security.

• **India should emerge as a global leader in science.**
India in global context

**STRENGTHS**

- Among World's top two exporters of IT services
- Very strong pharmaceutical industry with 10% of global market share and producing 25% of global generic drug production
- 60% of knowledge intensive output of India comes from services sector
- Trend of reverse R&D flow through acquisitions and overseas investments (example, Steel, Auto and Pharma companies)

**GAPS**

- Only 2% to 5% of those graduating in India have basic vocational skills, compared with 96% in Korea, 75% in Germany and 68% in the U.S
- 80% of exports are low tech.
- Lower share of business expenditure in R&D.
- R&D component in higher education is substantially low

Some of these trends are also reflected in the less than desired levels of impact of S&T in the socio-economic development.
India: 11th Plan S&T Accomplishments

- Gross expenditure on R&D - 0.9% of GDP
- Major successes in Space, Atomic Energy, Medicine, Defence R&D, Bio-technology, Earth Sciences, Industrial Science
- Trend of reverse R&D flow through major collaborations and acquisitions
- IPR regimes are increasingly harmonized across the globe
- Major knowledge work-force and capitalisation
- Global R&D Centres established

![Graph showing research and development expenditure]
India’s R&D Spending in global context

- World spends 1.2 Trillion dollars in R&D currently
- India spends 3% of total global R&D
- India’s gross expenditure in R&D is 0.9% of its GDP as compared to global average of 1.9%
- XII Plan aims to substantially boost R&D investments
“In order to promote a rapid development of activities connected with the Space Science, Space Technology and Space Applications, the Government of India consider it necessary to set up an organization, free from all non-essential restrictions or needlessly inelastic rules, which will have responsibility in the entire field of Science and Technology of Outer Space and their Applications”  June 1, 1972
NNRMS - Framework

PLANNING COMMITTEE-NNRMS
CHAIR: MEMBER (SCIENCE) PLANNING COMMISSION

DEPARTMENT OF SPACE
(Nodal Agency)
NNRMS SECT./
NRSA/SAC/RRSSCs/
NE-SAC

NNRMS STANDING COMMITTEES
CHAIR: SECRETARIES OF GOI
- Agriculture & Soils
- Water resources
- Bio-resources
- Geology & Minerals
- Oceanography
- Rural development
- Urban development
- Cartography
- Meteorology
- Training & Technology

PROJECTS

INFORMATION

MINISTRIES/DEPARTMENTS

STATE/DISTRICT DEPARTMENTS

STATE RS CENTRES

25

SNRMS 16

IMPLEMENTATION

~200 Entrepreneurs for Application Services

RS as PG Courses in 12 Universities & as Subject in 80 Universities (120 Depts.)
FOUR DECADES OF INDIAN SPACE PROGRAMME

34 LV Missions

62 S/C Missions

SELF RELIANCE & STATE OF THE ART TECHNOLOGY

BUDGET
~ USD 1.5 billion (2010-11)

HUMAN RESOURCES
16500 strong

APPLICATIONS LEADERSHIP

INDUSTRY

INTERNATIONAL COOPERATION

SPACE COMMERCE

LARGE USER BASE

INFRASTRUCTURE
End-to-end capability

34 LV Missions

62 S/C Missions

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SATELLITE COMMUNICATIONS - SOCIETAL RELEVANCE

TELEVISION
- Television Broadcasting
- Direct To Home (DTH)
- TV & Radio Networking

TELEPHONY
- Speech Circuits - Trunk Routes
- VSAT Connectivity

SOCIETAL
- Tele-health
- Tele-education
- Village Resource Centre
- Emergency Communication

WEATHER & CLIMATE
- Meteorological Imaging
- Extended Range Monsoon Forecasting
- Ocean State Forecasting
- Regional Climate Model

OTHERS
- Mobile Satellite Service
- Search and Rescue
- Satellite Navigation
- Data Collection Platforms

DISASTER MANAGEMENT
- Emergency Communications
- Disaster Warning Systems
- Data collection networking
- Image/Map Information Transmission

- TOTAL INSATS TILL NOW - 25
- CURRENTLY 9 IN-OBJECT
- L, S, C-EXT-C, KU BANDS
- TOTAL OF 187 TRANSPONDERS
- ESTIMATED NEED ~600 TRANSPONDERS
REMOTE SENSING - SOCIETAL RELEVANCE

AGRICULTURE & SOIL
- Crop Acreage/Production Estimation
- Soil & Land Degradation Mapping
- Watershed Development
- Horticulture Mission

FOREST, ENVIRONMENT, BIO
- Forest Cover & Type Mapping
- Forest Fire and Risk Mapping
- Biodiversity Characterisation
- Environmental Impact Studies

LAND AND WATER
- Land Use/Cover Mapping
- Wasteland Mapping
- City Management
- Potential Drinking Water Zones
- Command Area Management
- Reservoir Sedimentation

DISASTER SUPPORT
- Flood Damage Assessment
- Drought Monitoring
- Land Slide Hazard Zonation

OCEAN, COASTAL & ATMOSPHERE
- Potential Fishing Zone (PFZ)
- Coastal Zone Mapping
- Climate Modelling

• Enhancing Agricultural Production
• Optimisation of Water resources
  • Minimise Land degradation
• Bioresources conservation
  • Disaster Proofing
• Infrastructure build-up
GWATER DIAGNOSTICS REPORT

- POINT COORDINATE
- NAME OF PERSON
- CONTACT

REPORT:
- Map Unit
- Rock Type & Geological Sequence
- Geomorphic Unit/Landform
- Recharge Conditions
- Nature Of The Unit
- Type Of Wells Suitable
- Probable Depth Range Of Wells
- Expected Yield Range Of Wells
- Probable Success Rate Of Wells
- Reference No. Of Observation Wells
- Ground Water Irrigated Area
- Recharge Structure Suitable
- Problems/Limitations Remarks
### Wasteland Inventory & Monitoring

- **Monitoring of the wasteland areas (2005-06)**
- **Wasteland Change Analysis - using three season LISS-III data of 2008-2009**

Atlas on 'Wastelands of India' has been released by Hon'ble Minister of Rural Development on 27th July 2010.

#### Change in the total wasteland area of the country during 2005-06 and 2008-09

<table>
<thead>
<tr>
<th>No Change in area (M Ha) in wasteland class (NC)</th>
<th>Change in area (M Ha) from one wasteland class in 2005-06 to another wasteland class in 2008-09 (+ change)</th>
<th>Change in area (M Ha) from wasteland class in 2005-06 to non-wasteland class in 2008-09 (-change)</th>
<th>Net Change in wasteland area (M Ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>39.60</td>
<td>4.38</td>
<td>3.23 (at 1,12,057 locations)</td>
<td>0.52</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Area (Mha)</th>
<th>% of TGA</th>
<th>Year of Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>63.85</td>
<td>20.17%</td>
<td>1986 -2000</td>
</tr>
<tr>
<td>55.27</td>
<td>17.45%</td>
<td>2003</td>
</tr>
<tr>
<td>47.22</td>
<td>14.91%</td>
<td>2005</td>
</tr>
<tr>
<td>46.73</td>
<td>14.76%</td>
<td>2009</td>
</tr>
</tbody>
</table>
Biennial Forest Monitoring

Forest Survey of India undertakes

- SATELLITE IMAGES FOR WHOLE COUNTRY IS ANALYSED FOR FOREST COVER
- 1:50000 SCALE AND EVERY 2 YEARS FROM 2001
- PRESENT STATUS (AS OF 2011): 23.69% (~78.29 MHA) FOREST COVER; OPEN FORESTS – 28.78 MHA; MOD. DENSE FORESTS - ~32.07 MHA; VERY DENSE FOREST – 8.34 MHA
- TOTAL GROWING STOCK - 6047.15 M CU M (4498.73 M CU M INSIDE FOREST AREA + 1548.42 M CU M OUTSIDE FORESTS)
IMAGES AND GIS BASED NATIONAL URBAN INFORMATION SYSTEM

- CITY-1
- CITY-2
- CITY-3
- CITY-4
- CITY-5
- CITY-N

NATIONAL URBAN INFORMATION SYSTEM (COVER ALL CITIES)

- IMAGES
- MAPS
- URBAN INDICES

- METADATA

- UIS WEB-SERVER

- UIS APPLICATION ENGINE

- LANDUSE
- SOILS
- TERRAIN/PHYSIOGRAPHY
- CONTOURS/DEM
- POPULATION
- PROXIMITY TO TRANSPORTATION NETWORK
- ENVIRONMENTAL ASPECTS
- ECONOMIC DEVELOPMENT

- URBAN SPRAWL & GROWTH TRENDS
- URBAN LAND USE
- URBAN SUITABILITY ANALYSIS
- INFRASTRUCTURE PLANNING
- CITY GUIDE MAPS/TOURIST MAPS

K Kasturirangan, NU: Sep 3, 2011
SPACE IN SUPPORT OF DISASTER MANAGEMENT

- National Database for Emergency Mgt.
- Hazard Zonation & Early Warning
- VPN Communications
- Decision Support System

Flood Management
- Cyclone warning
- Landslide Hazard Zonation
- Flood & Cyclone Prone Districts

Decision Support Centre

Virtual Private Network for Disaster Management

K Kasturirangan, NU: Sep 3, 2011
Tele-Education and Tele-Medicine

Tele-Education

Jhabua Dev. Communications Project (1996)
GRAMSAT Pilot Project (Current)
EDUSAT Utilization Prog (Current)

> 35,000 Virtual Class Rooms

EDUSAT

Ku & Ext C
State Capital
VSAT Hub
Studio
HUB

0.9/1.2 m
ROT
School
1.2/1.8 m
Higher Sec./ University

Broadcast
Television Broadcasting
Direct To Home (DTH)
TV & Radio Networking

Communication
Speech Circuits on Trunk Routes
VSAT Connectivity

Mobile Applns
Mobile Satellite Service
Search and Rescue
Satellite Navigation

Tele-Medicine

375 Hospitals
305 Dist/ Rural Hospitals
57 Specialty Hospitals
13 Mobile Units

> 300,000 Patients treated

INSAT

Referral Hospitals
Video Conferencing
Cardiology
Pathology
Super Specialty Hospital
Referral Hospitals
Panel of Doctors

AMBULANCE
Panel of Doctors

> 300,000 Virtual Class Rooms
Strategy for Decision Making

Initiation of activities when justification for measurable direct benefit is lacking. Chandrayaan-1 example:

Decision making process of Chandrayaan-I

- **Presentation on Technology Day**
  - Germinating the Idea
  - May 1999

- **National Task Force**
  - Defining the Mission
  - Sep 2002

- **Presentation to Indian Academy of Sciences**
  - Interests of Scientific Community
  - Oct 1999

- **Discussions by Astronautical Society of India**
  - Response from astronautical community
  - Feb 2000

- **Parliamentary Standing Committee**
  - Political Sensitization
  - Apr 2002

- **Feasibility assessment**
  - Detailing / Analysis
  - Sep 2001

- **Endorsement by Space Commission**
  - Securing support of Policy makers
  - Jun 2003

- **Announcement By Prime Minister**
  - India enters planetary era.
  - 15th Aug 2003

- **Review by National Committee**
  - Expert review and endorsement
  - Apr 2003

Process spanned over four years and led to announcement by the Prime Minister on the national decision to enter the new era of planetary exploration.
A major discovery:

- Hydroxyl & water molecule on lunar surface material

Obtained several new results:

- reflected solar wind, lunar mini-magnetosphere
- sub-surface ice layers near lunar polar region
- water molecule in lunar atmosphere
- identification of new refractory rock types
- chemical composition (up to Fe) based on X-ray Fluorescence

Confirmed: Basic concept (the global magma ocean) of Lunar evolution.

Improved data on:

- lunar surface topography & mineralogy
- radiation environment in the lunar space
Nuclear Applications for Medical Science: Social Relevance

**Bhabhatron - II**
Productionisation through M/s Panacea Medical Technologies Pvt. Ltd., Bangalore

**ISOTOPE HYDROLOGY ANALYSER**
Groundwater analysis for age, velocity and direction of flow; Interrelations between surface and ground water

**Tele ECG**
Hand held, low cost blue-tooth/mobile instrument; Productionisation through M/s Chess Medicare Pvt Ltd., Mumbai
Rural Outreach of Nuclear Science: Social Relevance

FOLDABLE SOLAR DRYER

FIELD SOIL-ANALYSIS KIT

NISARGRUNA BIOGAS PLANT

PROCESSING BIODEGRADABLE WASTE MATERIALS GENERATED IN KITCHENS, VEGETABLE MARKETS, ABATTOIRS AND ETP OF FOOD AND TEXTILE INDUSTRIES

39 CROP VARIETIES THROUGH MUTATION BREEDING

GROUNDNUT  PIGEON PEA  BLACKGRAM  MUNG BEAN

RICE  JUTE  MUSTARD  SOYBEAN  SUN-FLOWER
Defence Research – Interface with Society

Agrotech: Fresh Foods

Transgenics – Vegetables; Resistance to cold and Osmotin gene integration

Proessed Food

Trains fitted WITH bio-toilets

66 Units functional in Siachen Sector

Bio-Toilets

Bio-Diesel

Jatropha farming
DIAGNOSTIC KITS & DISEASE PROTECTION

Immuno-PCR based Anthrax Detection Kit

Sandwich ELISA based Anthrax detection Kit

Microbial Meat quality evaluation kit

Milk testing kit

Dot ELISA based Ochratoxin detection kit

Salmonella, Shigela, E. coli & Proteus detection kit

Herbal medicine (Skin Diseases; Poisoning)

Malaria Control; Personal protection (Herbal Repellents, Vaporizer, Herbal medicine against P. falciparum); Mobile Clinic & Vaccine
Complementary & Supplementary Foods and Energy Food

- CSIR (CFTRI) Food products used in nutritional programmes of several states (nutrition is State subject).
- Energy Food reaches 7 million children per week.
- Other Products: Amylase rich Energy Foods, Protein rich Traditional Foods (Upma, Poha, Sattu etc.). Protein is twice the normal content of these foods.

End-to-end R&D Intervention for Nutritious Food

- Nutritionals
- Banana Juice
- Spirulina based products
- High protein foods
Wood Without Trees
Rice Husk Plastic Wood

- Technology developed CSIR-CBRI and commercialized:
  - Pallet capacity: 100 kg/hr
  - Profile production: 10 - 20 m/hr

Salient features:
- Replacement of natural wood
- Wood like surface appearance
- Meets requirement of National Building Code (NBC 2005, Sec 3, Timber)
- Termite resistant
- Carpenter friendly
Biotechnology products with impact on society and economy

**Discovery led innovation**
- Public/private sector
- Genetically Engineered
- Insect resistant Bt cotton

**Incremental innovation**
- Recombinant Hepatitis “B” vaccine

**Innovation for import substitution**
- Robotic positioning platform for Interventional Oncology

- **Indigenous development**
  - Cost reduction 80%
  - Coverage so far 600 M doses
  - Export to 70 countries
  - Part of National immunization programme at Rs 10 per dose

- **Indigenous development through PPP**
  - Cost reduction 50%

- 20% Increase yield and farm income
- 40% Pesticide reduction
- 85% Adoption rate
- 15% Associated reduction environmental impact
INDIAN 12th PLAN – FASTER, SUSTAINABLE AND INCLUSIVE DEVELOPMENT

• Energy
• Transport
• Sustainable NR
• Rural Transformation
• Farm Sector
• Manufacturing Sector
• Health

9% GROWTH

FOCUS ON DEPRIVED VULNERABLE GROUPS

EFFECTIVE GOVERNANCE

• Education & Skill Development
• Social/Regional Equity
• Science Technology
• Urbanization
• Tourism, Hospitality & Construction

HIGH AGRICULTURAL GROWTH (4%)
PHYSICAL, SOCIAL INFRASTRUCTURE.
LARGE MANUFACTURING THRUST
RURAL CONNECTIVITY
KNOWLEDGE TO COMMUNITY
S&T Strategies for 12th Plan

- Major step up of investment to 2% of GDP
- Incentivizing corporate sector to invest in R&D up to 1% of GDP
- Globalizing India’s R&D..Models like Jack Welch Centre
- PPP schemes, funding for problem solving and innovation oriented R&D
- Encouraging cluster ecosystems involving academic, professional, contract labs, Incubators, SMEs
- Discovery led innovations
- Global collaborative R&D (2X2, 1X1)
- Support to autonomous R&D institutions
- Venture participation
Propelling S&T impact on socio economic sectors through central ministries (Health, Energy, Water, Environment etc.,)

Enhancing S&T application impact through strengthening State mechanisms

Expanding and strengthening Industry base through research/ innovation inputs

Spin offs from strategic sector R&D

Enrichment pursuits for new generation

International Collaboration

Routes to Interface S&T to Social Needs..
Institutional innovations to bring synergy, structural reforms, rationalizing governance

- **Inter university centers**-
  - **Strengthening University research & creating excellence**
  - ~ 50 centres in various areas such as Biodiversity and Genetic epidemiology, Mathematical modelling, Functional materials, cyber security and computer science

- **Inter disciplinary Centres**
  - Synthetic and system biology, supercomputing applications etc,

- **Pan India initiatives**:
  - Solar Energy research & capacity 22000 Mw by 2020.
Mega Science initiatives

• Gaining Science Leadership (Examples)
  • India based Neutrino Observatory with ICAL detector
  • National Large Solar Telescope
  • Advanced Interferometric gravitational wave detector
  • ITER India
  • 30 m Telescope (TMT) India participation
  • Mars exploration
12th PLAN S&T – WAY FORWARD

SOCIALLY RELEVANT S&T

REVITALISE UNIVERSITY SYSTEM
(Inter-Univ Centres, upgrade infra, network to national labs)

THRUST FOR INNOVATION
(Clusters, PPP model, autonomous R&D)

S&T “DOVE-TAIL” TO AGRICULTURE
(Improve productivity, Soil health, Water efficiency, genetic crops)

GROWTH-ORIENTED S&T

THRUST FOR MATHEMATICS
(Focus on Higher/applied mathematics, National Centre for Mathematics)

S&T “DOVE-TAIL” TO HEALTHCARE
(Health Systems, Health care delivery, pharma research)

S&T “DOVE-TAIL” TO ENVIRONMENT
(Env. Governance, Env. Metrics/Mon, Climate Change & Eco. Missions)

ENHANCE KNOWLEDGE VALUE

STRENGTHEN INSTITUTIONAL SYSTEMS
(Integrate, link and dovetail; multi-agency matrix)

S&T “DOVE-TAIL” TO ENERGY
(Technology strategy, Solar/Wind/Biomass Missions)

BUILD NATIONAL S&T SYSTEMS
(National GIS, Weather Mon system)

BUILD LEADERSHIP

PVT SECTOR PARTICIPATION

BUILD HUMAN RESOURCES
In Conclusion

• Time is ripe now to recognize multidimensional social interfaces of S&T in nation building
• A paradigm shift in institutional mechanisms are needed if we have to realize the highest potential
• As investments in S&T are increasing, they have to be measured by objective economic and social achievements, as integral part of evaluation process
It is not a question of whether Science & Technology should be an integral part of development strategy but the question is whether India of today can afford to ignore them.