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Final Report

EVALUATION OF REMOTE SENSING CAPABILITIES FOR THE DETECTION OF HEAVY RAINFALL EVENTS IN THE SULTANATE OF OMAN

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RAINFALL REGIMES IN THE SULTANATE OF OMAN

The Sultanate of Oman, situated on the southeastern end of the Arabian peninsula, is characterized by an arid and semi-arid climate. During the winter months, primarily in January and February, rainfall originating from synoptic scale systems in the eastern Mediterranean Sea bring precipitation to the Sultanate. These rains tend to be widespread, generally of light to moderate intensity.

Convective rainfall is associated with a monsoon trough which is normally located in a northeast to southwest orientation extending across the Jebel Akhdar. During the late summer and late winter seasons, a flow of air originating over the Arabian Sea brings moist air northward into the monsoon trough. Afternoon showers, caused by the convergence and lifting of unstable air in mountainous areas, are sometimes very intense, resulting in flash floods in the wadis.

Tropical storms originating in the eastern Arabian Sea off the Indian sub-continent affect the southern portions of the Oman coast. These systems usually occur during the months of May-June and October-November, averaging one storm every two and a half years along the south coast. These systems occasionally move inland, producing heavy rains and strong, gusty winds.

Other systems producing heavy rainfall originate in the upper Bay of Bengal, traverse northern India, and affect the east coast of the Sultanate. These storms are often very intense, causing flash flooding in the Capital Region.

The occurrence of rainfall is highly variable, both in time and in location. In spite of this variability of location and frequency of occurrence, remote sensing can be an aid to the detection and forecasting of heavy rainfall events.

EXECUTIVE SUMMARY

The present contract between the Public Authority for Water Resources of the Sultanate of Oman and the Omani-American Joint Commission through the Environmental Research Institute of Michigan was established to provide expert advice in remote sensing and its application to flood forecasting. This advice was provided to the Public Authority for Water Resources, the Directorate General of Meteorology and other Sultanate of Oman government agencies by holding meetings with government officials and conducting two seminars and two workshops. One seminar and workshop was in the application of remote sensing to meteorology and the second seminar and workshop was in the application of remote sensing to flood forecasting.

Remote sensing capabilities of the Sultanate of Oman in the detection of cloudiness associated with flash floods was reviewed to ascertain current capabilities. Recommendations for the upgrading of capabilities in the detection and analysis of flash flood producing cloudiness are provided in this document.

Great strides have been made in observing, predicting and monitoring meteorological parameters associated with heavy rainfall events and predicting tropical storm intensities and associated rainfall.

Methods have been derived to predict rainfall intensities of small convective systems and intensities of tropical storms through the use of geostationary satellite images. These methods are continually being updated through the use of more modern methods such as interactive processing devices.

Rainfall information from large scale systems and tropical storm intensity analyses are being derived from both geostationary and polar orbiting satellite data.

Recommendations on the future trends of remote sensing in the Sultanate of Oman are based on the work that is being done in the field of hydrometeorology by remote sensing methods. These aforementioned methods have been highly successful in other areas of the globe, and it is highly likely that they can be modified to fit the precipitation patterns found in the Sultanate.

PRESENT CAPABILITIES

Remote sensing of the atmosphere for meteorological purposes resides within the Ministry of Communications Directorate General of Meteorology (DGM). DGM acquires satellite data through two antenna systems. A fixed position antenna is used to acquire geostationary satellite (METEOSAT) imagery from the European Space Agency. Four acquisitions are obtained daily with a viewing area from the United Kingdom to the Sultanate of Oman. The satellite position at a point over the equator at zero degrees Greenwich creates an oblique view over the Sultanate of Oman, resulting in some degradation of the data and resulting imagery. The data can, however, be used effectively for monitoring large weather systems, both tropical and extra-tropical, especially those affecting the western half of the Sultanate. Because the Sultanate of Oman is located at the extreme eastern edge of METEOSAT imagery, remote sensing for rainfall events in the Sultanate is very difficult. This is especially true for weather systems originating east of the Oman area.

The acquisition of polar orbiting satellite data is accomplished through the use of a tracking antenna system. A direct readout from the U.S. National Oceanic and Atmospheric Administration (NOAA) satellite series is acquired twice daily using the NOAA or TIROS series of satellites. Local area coverage is obtained whenever the satellite is in view of the Sultanate of Oman, resulting in a more complete view of weather systems. The acquisition of polar orbiting satellite data offers a more comprehensive opportunity for the study of large rainfall events; however, the smaller area and shorter life period of heavy convective events make it difficult to observe these systems using data acquired twelve hours apart.

The Indian satellite (INSAT), whose location is more suitable for observing the Sultanate, is received once daily. The INSAT imagery is received via a land line from the Indian Meteorology Centre in New Delhi. The image is degraded and is of little value at present. However, plans are in progress to upgrade the service and frequency of data acquisition from this satellite.

Both the METEOSAT and NOAA imagery are received on an Alden 350-3B facsimile recorder. The imagery recorded with this system is of good quality, yet there are times when this recorded data is degraded. Higher resolution imagery is necessary for use in flash flood forecasting. A Visual 60/65 color enhancer is used to enhance the imagery. The imagery is enhanced via color enhancement tables corresponding to infra-red observations of cloud top temperatures. This enables the meteorologist to observe the cloud fields in greater detail by highlighting the colder cloud temperatures which are used as indicators of rainfall.

Rain gauge information resides in several Ministries and is not readily available for correlating rainfall events with remotely sensed cloud systems. Heavy precipitation events occur at irregular intervals over relatively small areas making it difficult to receive rain gauge information on any particular event. Correlating remotely sensed data with conventional meteorological data is necessary to establish a reliable system for estimating precipitation amounts and intensities.

RECOMMENDATIONS

1. DATA COLLECTION AND DISSEMINATION

In order to more effectively monitor rainfall events through remote sensing, an expanded rainfall measuring network is desirable. A dense rainfall network in the main wadis could be a tremendous aid in correlating rainfall amounts with satellite cloud imagery. This would be especially desirable for flash flood monitoring in the Capital region with its large concentration of people. It would also be useful in developing a stream flow/rainfall relationship for other areas susceptible to flash floods. Other recommendations include:

A. Establish a central collection point and archival unit for the rain gauge network. This could reside in the Directorate General of Meteorology.

B. Study the feasibility of placing stream gauges and rainfall measuring equipment in common areas. This would cut down on the amount of area to be covered when servicing equipment.

C. Look into the feasibility of setting up a Data Collection Platform (DCP) to record rainfall data that is then transmitted to Muscat via weather satellites.

D. Establish a method of disseminating remotely sensed data in a real-time environment to appropriate agencies. The needs of the various agencies requiring information would have to be made known to the disseminators of these data. This function could also reside within the Directorate General of Meteorology since the real-time monitoring of rainfall events is a meteorological responsibility.

2. ACQUISITION AND ANALYSIS

Rainfall intensity estimates through remote sensing fall into two categories, rainfall potential and rainfall intensity. Rainfall potential from large tropical systems can be estimated via observations every twelve hours. Whenever landfall is expected within a twelve hour period, the frequency of observations should be increased to six hours or less. Estimation of the potential rainfall amounts and the strength of the storm for maximum wind velocities as the system approaches land can be best accomplished through more frequent image acquisitions. Rainfall for smaller, intense storms, which have life cycles of six hours or less, require imaging at intervals of three hours or less to effectively predict rainfall intensities.

In order to maximize the use of satellite imagery for estimating rainfall intensities, more frequent imaging is needed. Presently the only meteorological satellite that shows promise for the Sultanate of Oman is the INSAT geostationary satellite. Improved imagery at a frequency of three hours or less from INSAT would be needed to create a flash flood rain monitoring capability within the DGM. To improve present capabilities for monitoring large systems for rainfall events, a separate ground station for the acquisition of Advanced Very High Resolution Radiometer (AVHRR) data should be studied. These data would provide high spatial resolution imagery for interpreting the rainfall potential of rain bearing cloud systems. A full tracking and telemetry reception system for the acquisition of AVHRR data would be advisable for the monitoring and study of large scale weather system events. This high resolution system can be used to estimate rainfall amounts based on the acquisition of polar orbiting data. These data can be obtained twice daily with one satellite or four times daily with a two satellite system. In addition, a system of this type can be used for monitoring other environmental parameters for oceanographic and agricultural interests. Estimated costs for acquiring a system of this type, including the computers necessary for processing the data, range from approximately $200,000 to $1,000,000.

An interactive computer system for the display and analysis of geostationary imagery is vital in order to establish a system to estimate the intensities of small scale, heavy rainfall events. This system should have the ability to enhance the imagery through a large temperature range within the infra-red band. This would enable the meteorologist to observe cloud top temperatures which are usually an indicator of heavy rainfall. In addition, the interactive processor should have animation capabilities. This added capability would enable the meteorologist to observe cloud growth of small intense storms at half hourly intervals to determine the rate of growth of individual clouds, an important determinant in computing the rainfall intensities of convective storms. This man-machine interactive system should be capable of melding regular meteorological analyses and observations with satellite data. This is essential for the rapid analyses of rainfall intensities. A complete unit, including computer interface with work station and hard copy output, is estimated to cost from $750,000 to over $1,000,000.

One additional possibility to improve remote sensing acquisitions for flash flood monitoring and forecasting is by creating a separate image sector over the Sultanate of Oman from METEOSAT imagery through computer mapping. This would rectify the image to provide a more direct view of the Sultanate. However, the benefits and time constraints placed on this method of operation would in all probability not make it worthwhile.

The Directorate General of Meteorology has the most immediate need of remotely sensed data for operational use. It is therefore recommended that the control of remote sensing activities for meteorological considerations reside in this Directorate.

3. METEOROLOGICAL TRAINING

Training in the analysis of satellite imagery for determining rainfall intensities of convective systems is highly recommended. Such training can take place in the Applications Laboratory and Synoptic Analysis Branch of the National Environmental Satellite Data and Information Center of the U.S. Government, specifically in the area of tropical storm analysis for determining tropical cyclone wind maxima and rainfall potential. Additional training in flash flood forecasting through remote sensing can be acquired through this same organization. If it is not possible to release Directorate General of Meteorology personnel for training abroad, a study should be made to consider training personnel within the Sultanate of Oman in various satellite meteorology disciplines.

The Omani-American Joint Commission, in cooperation with concerned Sultanate of Oman government agencies, should explore the possibility of providing opportunities for on-the-job training to qualified candidates through the above methods.

Some of the recommendations listed in this report are now planned or under consideration by the Directorate General of Meteorology.

ACKNOWLEDGEMENTS

I would like to give thanks to the people who were instrumental in making this report possible and for making the seminars and workshops a success. I want to especially thank Mr. Rodney Lynn, Training Officer of the Public Authority for Water Resources, for his tireless efforts to ensure that materials and necessary government documents were provided to ensure entry to government buildings. My heartfelt thanks for having this document ready before my departure from the Sultanate of Oman and a special thanks for taking care of all the other details associated with the seminars and workshops. I also want to single out Mr. Arnold Ivan Johnson of the Omani-American Joint Commission (Training Consultant) for making arrangements for meeting people responsible for training in the various Ministries. This was responsible for generating a widespread interest in the seminars and workshops.

I also extend heartfelt thanks to Mr. Mohammed Bin Salem Al Busaidi, Deputy Director General of the Directorate General of Meteorology, for arranging entrance passes for myself and the participants and for arranging space and equipment. I appreciate the effort spent in making these arrangements in the very little time allotted.

Thanks also go to Mr. David Mandel and Mr. Edvard Markeset of the Omani-American Joint Commission and Mr. William Doyel and Mr. Robert Dingman of the Public Authority for Water Resources for their help in guiding us in the right direction and for the freedom in allowing me to contact people interested in remote sensing.

Finally thanks to all the other people involved, the many people whose names escape me.

APPENDIX A

LIST OF PUBLICATIONS PROVIDED TO PAWR

1. Navy Tactical Application Guide
   Volume 1: Techniques and Applications of Image Analysis
   Volume 2: Environmental Phenomena and Effects
   Volume 5: Weather Analysis and Forecasting Applications
   Part 1: Indian Ocean Red Sea/Persian Gulf

2. Technical Note 3WW/TN-81/001 Satellite Interpretation

3. Tropical Cyclone Intensity Analysis Using Satellite Data, NOAA Technical Report NESDIS 11

APPENDIX B

MATERIALS COVERED IN SEMINARS AND LIST OF PARTICIPANTS

SEMINAR 1

APPLICATION OF REMOTE SENSING TO METEOROLOGY

1. Meteorological Satellites and Sensors

2. Large Scale Systems in the Westerlies
   (a) Surface Systems
   (b) Upper Air Systems

3. Tropical Weather Systems
   (a) Tropical Storm Classifications

4. Movie on Understanding of Weather Systems as Viewed from Meteorological Satellites

SEMINAR 2

REMOTE SENSING APPLICATIONS TO FLOOD FORECASTING

A. Estimating Area Coverage Rainfall

B. Estimating Rainfall Potential from Tropical Storms

C. Estimating Rainfall Intensities of Small Scale Convective Storms

LIST OF PARTICIPANTS

NAME	ORGANIZATION
Saleh Bin Khalaf Bin Nasser Al Mawaly	Public Authority for Water Resources (PAWR)
Hamad Bin Salim Bin Hamad Al Makdaly	PAWR
Ahmed Bin Said Bin Hilal Al Barwany	PAWR
Yaser Bin Salim Bin Rashid Al Harthy	PAWR
Hamed Bin Salim Bin Hamed Al Mahrooqy	PAWR
Murad Bin Ali Bin Karam Al Baluchi	PAWR
Hamid Juma Hamid Al Sabany	PAWR
Said Bin Ahmed Bin Suleiman Al Hattaly	PAWR
Gyanesh Chandra Bhatnagar	PAWR
Gordon Stanger	W.S. Atkins (for PAWR Nizwa)
Mohammed Salem Zahor Al Bussaidi	Directorate General of Meteorology (DGM)
Ahmed Hamood Mohamed Al Harthy	DGM
K. Rajagopalan	DGM
Saeed Parwiz Iftikhar	DGM
Sajjad Hasanain Jawad	DGM
Subhi Hassan	DGM
Yahya Kindi	DGM
Yussuf A. Bahri	Ministry of Environment
Majid Bilarab Sultan El Batashi	Ministry of Agriculture & Fisheries (MAF)
Ishtiad Ahmed Khan	
Dhudi P.M.	DGM
Suleiman Nasser Al Riyami	PAWR
Suleiman Abdulla Al Jahdhamy	DGM
Afifa Said Al Falahy	Ministry of Petroleum & Minerals (MPM)
Arnold Ivan Johnson	Omani-American Joint Commission
Yahya Ramadan Karim Al Balushi	Council for Conservation of Environment & Prevention of Pollution
Emad Abdul Majid Abdul Baqi	MAF
Robert Peter Whitcombe	Planning Committee, Southern Region
Yussuf Abdullah Saif Al Bahri	Ministry of Environment
Bruce J. Blanchard	Omani-American Joint Commission
Said Mubarak Al Zehibi	DGM
Abdallah Said Al Shukry	PAWR

APPENDIX C

MATERIALS COVERED IN WORKSHOPS AND LIST OF PARTICIPANTS

WORKSHOP 1

WORKSHOP ON APPLICATIONS TO METEOROLOGY

Because of the length of the seminar, a brief exercise was handed out at the end of the day on:

Pattern Recognition in Estimating Strengths of Tropical Storms

WORKSHOP 2

WORKSHOP ON FLOOD APPLICATIONS

1. Exercise in estimating rainfall over an area
2. Exercise in estimating rainfall potential of tropical storms

LIST OF PARTICIPANTS

NAME	ORGANIZATION
Saleh Bin Khalaf Bin Nasser Al Mawaly	Public Authority for Water Resources (PAWR)
Hamad Bin Salim Bin Hamad Al Makdaly	PAWR
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Yaser Bin Salim Bin Rashid Al Harthy	PAWR
Hamed Bin Salim Bin Hamed Al Mahrooqy	PAWR
Murad Bin Ali Bin Karam Al Baluchi	PAWR
Hamid Juma Hamid Al Sabany	PAWR
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Gyanesh Chandra Bhatnagar	PAWR
Gordon Stanger	W.S. Atkins (for PAWR Nizwa)
Mohammed Salem Zahor Al Bussaidi	Directorate General of Meteorology (DGM)
Ahmed Hamood Mohamed Al Harthy	DGM
K. Rajagopalan	DGM
Saeed Parwiz Iftikhar	DGM
Sajjad Hasanain Jawad	DGM
Subhi Hassan	DGM
Yahya Kindi	DGM
Yussuf A. Bahri	Ministry of Environment
Majid Bilarab Sultan El Batashi	Ministry of Agriculture & Fisheries (MAF)
Ishtiad Ahmed Khan	
Dhudi P.M.	DGM
Suleiman Nasser Al Riyami	PAWR
Suleiman Abdulla Al Jahdhamy	DGM
Afifa Said Al Falahy	Ministry of Petroleum & Minerals (MPM)
Arnold Ivan Johnson	Omani-American Joint Commission
Yahya Ramadan Karim Al Balushi	Council for Conservation of Environment & Prevention of Pollution
Emad Abdul Majid Abdul Baqi	MAF
Robert Peter Whitcombe	Planning Committee, Southern Region
Yussuf Abdullah Saif Al Bahri	Ministry of Environment
Bruce J. Blanchard	Omani-American Joint Commission
Said Mubarak Al Zehibi	DGM
Abdallah Said Al Shukry	PAWR

APPENDIX D

PERSONS CONTACTED

Omani-American Joint Commission

David Mandel	Acting AID Representative
Edvard Markeset	Chief Engineer
Ivan Johnson	Water Resources Training Consultant

Public Authority for Water Resources

William Doyel	Technical Secretary
Robert Dingman	Head, District Offices Department
Rodney Lynn	Training Officer
Melving Thompson	Head, Surface Water Unit
Wayne C. Curry	Engineer, Surface Water Unit
George Piperingos	Chief Geologist
George Courtney	Geologist

Public Authority for Water Resources, Interior District

G. Chase Tibbetts	District Chief, Interior District
Gordon Stanger	Consulting Geologist, W.S. Atkins
Kent Kane	Assistant to District Chief
John Mahalich	Contract Geologist
Jose Bustamante	Contract Geologist

Ministry of Communications Directorate General of Meteorology

Mohammed Bin Salem Al Busraidi	Deputy Director General
Ahmed Al Harthy	Acting Director of Climatology and Meteorology
Subhi Hassan Abdul Ali	Acting Director Forecasting and Observing Practices
Ahmed Ba-Omar	Director Regional and International Affairs Division

Ministry of Defence, Engineering Division

Robert Wheatley	Chief Engineer
Abdulla Ali Al Harthy	Manager, Water and Public Health Services

Hamed M.L. Mahruky	Training Director
N.T. Whitworth	Senior Public Health Engineer

Ministry of Electricity and Water

Ralph Leidholdt	Director Public Utilities, Capital Area Municipalities

Ministry of Agriculture and Fisheries

Majid Al Khanjari	Director of Administration, Directorate General of Water Resources and Irrigation
Zakaria Yahya Al Riyami	Head, Water Resources Department
Ali Nassar Al Harthy	Chief, Administration & Financial, Water Resources Department
R.A. Abou Saia	Civil and Water Resources Engineer, Water Resources and Irrigation
Hamdi Abu Zayd	Administration Expert

Sultan Qaboos University

Abdul Majed Osman	Acting Vice Chancellor

APPENDIX E

BIOGRAPHICAL SKETCH

Mr. Frank J. Smigielski is a consulting meteorologist with Intercon Weather Consultants, Suitland, Maryland, U.S.A., specializing in environmental satellite image interpretation for atmospheric phenomena. His expertise is in the area of meteorological applications of remote sensing.

Mr. Smigielski is retired from the National Environmental Satellite Data and Information Service (NESDIS) of the United States Government. He has been involved in the interpretation of satellite imagery since 1962. Mr. Smigielski is the author of several articles on the application of satellite imagery to analysis and forecasting. His last position with NESDIS was Chief of the Synoptic Analysis Branch.

Mr. Smigielski received his meteorological training through the U.S. Air Force with follow up training at George Washington University and Pennsylvania State University, both in the U.S.

He was a member of the National Weather Service from 1950 until he entered the Satellite Service twelve years later.

Mr. Smigielski is a member of the National Weather Association, an organization devoted to operational aspects of meteorology.

LITERATURE SEARCH

American Meteorological Society, Boston, MA. "Third Conference on Hydrometeorology", V+141p.

American Meteorological Society, Boston, MA. "Second Conference on Flash Floods of the American Meteorological Society", VI+259p.

Brunsveld van Hulten, H.W.; Hoogeboom, P.; Jacobs, A.F.G.; Kraan, C.; de Loor, G.P.; "Contributions to Remote Sensing: Applications of Thermal Infrared", 1984, 120p. Report No.: COMMUNICATION-34/1984.

Council for Scientific and Industrial Research, Pretoria (South Africa); "Proceedings of the Seminar on Principal Components Analysis in the Atmospheric and Earth Sciences Held at Pretoria, South Africa on February 7-8, 1983", 198p.

Kaplan, L.D.; Hoffman, R.N.; Isaacs, R.G.; Rosen, R.D.; Salstein, D.A.; "Outlook for Improved Numerical Weather Prediction Using Satellite Data with a Special Emphasis on the Hydrological Variables", 18 November 1983, 198p. Atmospheric and Environmental Research, Inc., Cambridge, MA. Report No.: SCIENTIFIC-2; P79-1; AFGL-TR-83-0305.

Kogbe, C.A.; "Landsat Imagery Interpretation as a Tool in the Exploration for Groundwater in the Federal Capital Territory of Nigeria", Department of Geology, Aahmadu Bello University, Zaria, Nigeria, J. Afr. Earth Sci. (GB) Vol. 1, No. 3-4 327-30 1983 CODEN: JAESD8 ISSN: 0731-7247.

National Technical Information Service, Springfield, VA; "Agricultural Watersheds. 1977-April 1985 (Citations from the Selected Water Resources Abstracts Data Base)", May 1985, 240p.

Prevot, L.; Bernard, R.; Taconet, O.; Vidal-madjar, D.; Thony, J.L.; "Evaporation from a Bare Soil Evaluated from a Soil Water Transfer Model Using Remotely Sensed Surface Soil Moisture Data", January 1983, 30p. Centre de Recherches en Physique de l'Environnement, Issy-les-Moulineaux (France). Report No.: CRPE-NT-125.

Rosenfeld, C.L.; Beach, G.L.; "Evolution of a Drainage Network: Remote Sensing Analysis of the North Fork Toutle River, Mount St. Helens, Washington", Oregon State University, Corvallis, November 1984, 108p.

اخرى تتعلق ببرامج التدريب واحتياجات التوظيف الهام لتطوير كل الطلبات المتوقعة للبيانات المتوفره حاليا والخاصه بالاستشعار من على البعد وتكنولوجيتها .

وبصفه عامه فان التقرير بوجز الملاحظات والخلاصات والتى قام باعدادها اثنين من الاستشاريين وذلك فيما يختص بالوضع الحالى للاستشعار من على البعد فى سلطنة عمان بالاضافة الى احتياجات المدى القريب ومتطلبات المدى البعيد للحصول على، واختيارات الاستخدام لهذه التكنلوجيا .

موجز تنفيذي

تم انشاء العقد الحالي بين الهيئة العامة لموارد المياه وبين اللجنة العمانية الامريكية المشتركة عبر معهد الابحاث البيئية في متشجان وذلك لتوفير الخبره الاستشاريه في مجال الاستشعار من على البعد وامكانية تطبيقها على موارد المياه بالسلطنة . وقد أُخذ في الاعتبار الاستشعار من على البعد في كل من انظمة الارصاد الجويه والموارد الارضيه . تم توفير هذه الاستشارة الى الهيئة العامة لموارد المياه ، المديرية العامة للارصاد الجويه والدوائر الحكومية الاخرى في سلطنة عمان وذلك عن طريق عدة اجتماعات مع المختصين في الوزارات والدوائر الحكومية ذات العلاقه بالاضافة الى عقد خمس ندوات وورش عمل .

تم تخصيص الندوة الاولى حول اسس انظمة الاستشعار من على البعد . ثانيا تم عقد ندوة وورشة عمل حول تطبيقات الاستشعار من على البعد على الارصاد الجوية وتبع ذلك انعقاد ندوة وورشه عمل حول تطبيقات الاستشعار من على البعد على تنبؤ الفيضانات . كما كانت الندوة وورشه العمل الرابعة والخامسه حول جرد مصادر المياه بالاضافة الى الرقابة و ترتيب استخدام الاراضي وتحليل سطح الارض وذلك عن طريق استخدام اساليب الاستشعار من على البعد . وشملت ورشة العمل الاخيرة معرفة وتحديد المعالم الخطيه في صور جويه على نطاق واسع من اقمار صناعية للمصادر الارضيه .

تم مراجعة الامكانيات المتاحه والاستخدامات الحاليه للاستشعار من على البعد في سلطنة عمان بواسطة عدة دوائر حكومية . وجاءت التوصيات لترفيع الامكانيات فيما يختص بكشف حوادث الارصاد الجويه للحصول على مسوحات نبطيه طيفيه متعدده ومبحث خرائط جويه ، وانشاء أجهزة داخل القطر وذلك لاستلام ومعالجة بيانات الاستشعار من على البعد في المستقبل . كما جاءت توصيات