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Perspective Analysis of Water Resource Management Satellites – Technical Aspect

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Abstract: *Remote Sensing field is the fastest growing technology in digital world. Remote Sensing's contribution to technology development is very high and highly efficient. Each country has an important of the remote sensing because it provides more contribution for making from food production development till country security. Water management is the significant parameter to measure the development of a country. Water resource management output reflects the economic growth of a nation. Each country has been implementing water resource management with the help of satellites to overcome the drought problem. It has been benefiting from the digital technology of satellite artifacts for water needs, Water irrigation development, Marine water surveillance, Lake Connectivity, River water connection. Satellites perform specially for the particular field through its unique character. This paper helps to determine the water resource management satellites with the satellite technical specifications.*

Keywords: *Remote Sensing, Water Resource Management, Satellite Technology, Satellite artifacts, Lake connectivity, Marine water Surveillance.*

I. INTRODUCTION

Remote sensing is an essential and important technology to classify and predict objects on earth surface environment. Remote sensing technique supports numerous applications such as agriculture, infrastructure development, disaster monitoring and mitigation, forestry, marine resources, biodiversity, coastal zone, ground water prediction, land use, water resources, prediction of environmental changes, geology [1] etc. among these fields water resource management has a enormous role to avoid such issues of climate control, energy and food production, water supply management etc.

Some necessary problems should be needed to study to avoid the issues of water scarcity which are hydrological extremes contaminations. Hydrological extremes occur due to disaster events like overflow, mudslides, floods etc. Water resource is the global demand to increase the food production in the field of agriculture. Energy generation, public drinking supplies, irrigation and production of food entirely based on the availability of water. In the hydrological cycle, based on the quality and quantity of water climate changes has occurred. The regional and national economics absolutely depends upon the water resource management [2]. That is why; this research paper designed entirely based on the importance of water resource management in remote sensing technology.

Applications of remote sensing in water resource management are briefly discussed here. Applications are drought monitoring, flood forecasting, irrigation management, rain water harvesting, watershed planning and management, ground water studies etc.

Around the world droughts are the major natural hazards to destroy the environment and economy of country. Due to the impacts of droughts numerous issues are created such as environmental destruction, economic damage etc [3]. For irrigated area, yan et al.[4] can find accurate detector of agriculture droughts using NDVI calculation which has provide the vegetation health index.

Flood forecasting applications and flood alert system are contributes more complex results by satellite technology. Hydrodynamic modeling has plays a major role to determine flood level with specific location accurately. Two kinds of prediction errors occurred in forecast system, which are missed predictions and false alerts. Missed predictions have a short term impact like flood damage as well as loss of life. False alerts reduce the forecast credibility [5]. In try season, to identify the irrigated area ground truth observation and spectral analysis were used. Some of the significant satellites are described here which has working for hydrology and flood monitoring system. Landsat 4 and 5, SPOT, NOAA, IRS1C/1D, Envisat, ERS 1,2, Radarsat are the satellites detail discussed bellow.

Groundwater management is an essential and important application of remote sensing technology in water resource management. Groundwater assessment process generally divided into three criteria: geographical parameters used for groundwater modeling, groundwater storage estimation and potential estimation of groundwater [6]. For groundwater studies the popular usable sensors are TM, IRS, LISS.

For water saving the better water resource management and planning are the essential to maintain the world growth as well as good economic level. To monitor the earth's water resources space based earth observation should be needed. The space based earth observation has implemented by the satellite technologies using remotely sensed data. This research paper gives the clear discussion about the technical details of satellites which are used to managing the water resources.

Water Body Identification using Remote Sensing

Water resource identification using remote sensing is a challenging task in classification process. Water bodies like River, Lake and Sea are classified using reflection values. The spectral reflection from a water resource is complex for low and medium resolution electromagnetic images. While using a passive sensor, Electromagnetic radiation reflection on water may be absorbed, scattered and transmitted. The Spectral band reflection may vary based on the wavelength and type of the water resource surface. Clean water has the high reflection 0.4μm to 0.6μm in visible bands wavelength. Clean water having very minimum reflectance value in Near-infrared band. The following figure 1 displays the passive sensor uses for water resource observation process.

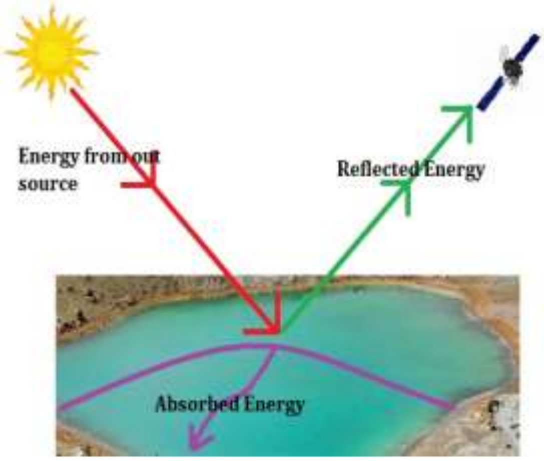

Figure 1: water resource observation using passive sensor

Remote sensing water management supports the Earth observations related to water demand, scarcity, supply, and water quality. The Water Resources Management focuses on primary concepts of drought, flow and flood forecasting, evaporation and irrigation, water quality and Climate effects in water resources. Remote sensing is used to reliable observation in hydrological states and fluxes on water resources.

Remote sensing and hydrologic models support the water resource management applications. It provides the valuable information through continues observation. Water resource management applications focused on real time issues like agriculture, food security, drought forecasting and mitigation

Hydrological studies Using Remote Sensing

Hydrological studies using remote sensing is a really challenging task due to seasonal changes and sudden rain falls. Small pools are filled suddenly by the unexpected rain falls. Unusual seasonal changes cause to sudden groundwater level changes. Satellites are continuously monitoring the environment to balance the climatic analysis and forecasting risks. Every satellite having one or more sensors with the separate spectral channel to observe the land cover condition. Water resource depth analysis is a complicated task using water resource surface conditions[11].

Satellites for water resource management

Water resource management satellites continuously monitor the surface. It's necessary for intensive data analysis. Satellites Provide Hourly, Daily, Seasonal, and Multi-Year Time Scales data to analyse the details about Rain, Ground Water, Soil Moisture, Snow and Ice, Temperature, Humidity, Winds, Surface Radiation, Vegetation Index, Evapotranspiration. Water resource quality is measured based on some parameters like watercolour, soil moisture and temperatures and so on. Remote sensing applications support for major Hydrological managements like rainfall studies, drought monitoring, flood forecasting, rain water harvesting and groundwater studies. Microwave bands and Infrared sensors are used to find the water depth in flooded areas. Crop health, irrigation level prediction and soil moisture also can be identified using remotely sensed data.

Table 1: List of satellites launched to analyze the seasonal change.

Satellite Name	**Service**		**Process**
	From	**To**	
Tropical Rainfall Measuring Mission (TRMM)	11/1997	04/2015	Precipitation
Landsat	07/1972	Till date	Evapotranspiration
Terra	12/1999	Till date	Snow Cover, Vegetation Index
Aqua	05/2002	Till date	Snow Cover, Vegetation Index
Soil Moisture Active Passive (SMAP)	01/2015	Till date	Soil Moisture
Gravity Recovery and Climate Experiment (GRACE)	03/2002	Till date	Ground Water
Jason 1, 2, 3	12/2001	Till date	Reservoir Height

The above table 1 shoes the list of satellites used for seasonal changing monitoring. Service duration and the purpose of the satellites also tabulated [7][8].
Satellite sensor plays the vital role to take the earth imagery. The imagery quality and imagery type are classified based on the sensor configuration and the sensor specification model. Satellite purpose fulfilled based on the sensor.[12]

Table 2: Satellite sensors and configuration model

Purpose	**Satellite / Sensor**	**Model**
Rain Amount	GPM /(GMI, DPR) & TRMM /(TMI, PR) – IMERG and TMPA Multi-satellite data	GLDAS & NLDAS forcing data from NOAA
Snow Cover	Terra & Aqua/MODS	GLDAS & NLDAS
Soil Moisture	SMAP/(Microwave Radiometer)	GLDAS & NLDAS
Land Cover And NDVI (For ET Estimation)	Landsat/OLI Terra & Aqua/MODS	GLDAS & NLDAS
Runoff	Landsat	GLDAS & NLDAS
Ground Water	GRACE/K-band Ranging System	GLDAS & NLDAS
Reservoir Height	Jason/Altimeter	GLDAS & NLDAS

The table 2 illustrates the sensors and satellite configuration models which are used to water resource management[8][9].

Rainfall estimation and monitoring

Remote sensing satellites help to the weather forecasting using continuously observed sensor data. Hydrological rainfall observation process considers various parameters to forecast the seasonal change. The boundaries which are getting rain, the rainfall level in a particular time, assessing the extreme events while heavy rainfall, regional rain level forecasting are the assessments done by the remote sensing[12].
The following table 3 used to display the satellites, spectral bands and the resolutions which are used to rainfall estimation and monitoring process.

Table 3: Rainfall estimation and monitoring satellites.

Satellite	**Spectral Bands**	**Resolution**
MTSAT,NOAA-19	VIS,IR	Spatial:1-4km Temporal:30min
TRMM	VIS,IR, Passive & active Microwave	Sub-daily,-27km spatial resolution

GEOS-8,10,GMS,TRMM,NOAA-15,16,17	IR	Spatial: -27 km Temporal: 30min.
AQUA,TRMM,NOAA-15,16,17,18	Microwave	Spatial:8km Temporal:30min

Table 4: Flood monitoring satellites and coverage duration.

Satellite	Sensors	Resolution	Temporal Coverage
NOAA	AVHRR	~1.1 km	Daily coverage, poor cloud penetration
Terra	MODIS	250 m	Daily coverage, poor cloud penetration
Landsat 4,5	Landsat TM	30 m	16 days once, poor cloud penetration
ERS 1,2, Radarsat	SAR	20-30 m	1 to 3 days, good cloud penetration

List of satellites, satellite sensors, Resolution of the coverage and periodic duration are tabulated in Table 4.

Table 5: Water resource satellites and specification details

Parameter	Satellite/ Sensor	Wavelength / Frequency	Coverage	Periodic cycle
Snow area	NOAA	0.62, 10.8mm Bands 1, 4	1 km	2 per days
Snow Depth	GOES	0.65 mm	2 km	2 per days
	Nimbus 7	37 GHz		2 per days
Snow water equivalent	SSM	19.3, 37 GHz	30 km	2 per days
	MOS-1	23, 31 GHz	25 km	2 per days
	MSR		23- 32 km	2 per days
Changes in snowmelt	ERS -1	5.3 GHz C- band SAR	30 km	Once in 35 days
Surface Temperature	NOAA	10.80 mm Band 4	1 km	2 per days
Evapotranspiration	NOAA	0.62,0.91,10.8,12.0 mm	1 km	2 per days
	GOES	0.64,11.5 mm	2-8 km	2 per hour
Precipitation Land cover/ Land use Vegetation	Meteosat	0.65 mm	3 km	2 per hour
	Landsat 5	0.55, 0.65,	80 m	8-16 days
	MSS	0.75,0.95 µm		2 per day
	NOAA	0.62,0.91 µm	1 km	5 days
	IRS IC/ID	0.92,0.67 µm	188 m	8-16 days
Ground Water	Landsat	0.95 µm	80 m	8-16 days
Water depth	Landsat	0.48,0.56,0.66 µm	30m	8-16 days
Oceanography	IRSP4	412,443,490,520,555,670,765mm	360m	2 days
	OCM MSMR	6.6,10.65,18,21 GHz		2 days

The table 5 shows the list of satellites and basic configuration details which are used to water resource management and Hydrological related studies. Satellite and airborne remote sensing provides the precious information and it is used to sustain the water resource society for management practices and decisions [8][9][10][11].

II. CONCLUSION

In this digital world, remote sensing is the most effective field to help the human society with various aspects like communication, seasonal change prediction, climatic analysis and so on. Now, the entire world is facing the drought problems and water resource management issues. Now a day, remote sensing uses in hydrologic modeling is very high. Most important reason for this is man research finds the shortest method to use the remotely sensed data for operational research and distributed process. It helps to process the data in a parallel mechanism. This mechanism helps to find the solutions in a short time. Remote sensing plays a vital in this process and can address the water resource management problems. This paper helps to analyze the water resource management and hydrological studies satellites with its technical specification and detailed configuration.

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