# An Application of Satellite Images and Coastal Radar System for Oil Spill Monitoring

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**Abstract**: The oil leaks and oil releases into the sea are often found in the gulf of Thailand. These caused a serious circumstances and damages to natural resources, environment and communities surrounding the affected area. A prompt action on collecting and limiting the spread area of oil stain can reduce some degree of damages and losses. Therefore, the oil spill monitoring is very substantial tool for planning to mitigate the damages and losses. This paper exploits the use of information derived from the coast radar system together with satellite images to identify and trace the movement direction of oil stains.

The case study of this paper was an event of a bunker oil ship collapsed in Parkklonpramong estuary, Samutsakhorn Province on April 7, 2014. The images taken by Landsat-8 were analyzed together with the information of water tides derived from the coast radar. It was found that by using wave range 7,6,4 and underline Histograms Equalize images, a fault color mixture was clarified over the prospective area of oil stains. The further analysis based on the method of Supervised classification in type of maximum- likelihood was to find a boundary and prospective position of oil. The evaluation accuracy was taken place by using data coordinate of the oil stain informed by fishermen. The result was 82% accuracy. Furthermore, the sea drifts movement model had been established by input the tide data from the coast radar system for an analytical system and processing as well as to specify a spot expected as the oil stain which analyzed by the satellite images in order to follow the oil stain movement.

It found that the tide moved to the North (inshore) during 17.00 - 04.00 hours on 7 - 8 April 2014, tide speed 20-30 cm./sec and moved to the South (offshore) during 06.00-16.00 on 8-9 April 2014. This caused the area of Parkklongpramong estuary and the coast lines of mangroves nearby effected with such oil stains and its movement to the Southeast and the Northeast during a short time 2-4 hours which was a time of direction change from the North and the South of the day cycle whereas the area get affected by such oil stains were Klongpramong estuary and the coast areas of Bangkhuntian District, Bangkok Metropolitan. However, during the oil movement direction analysis implement it was reported from a unit in charge that the oil stain collection process had been effectively done as per the direction informed by GISTDA in time.

The application of satellite image data together with the coast radar system has been accepted highly useful due to it can be effectively used for a collection plan for the oil stain and the sea drifts which may affects resources, environment and local people.

## 1. Introduction

From the event of flood disaster in 2554 that huge mass of water flowed and passed to estuary and the gulf of Thailand causing and changing the water quality and affecting many animal cultivated areas and the coastal agriculture area. Management of area effects rarely met problems because of appropriate data base lack for prevention and warning to the affected areas because the exact moving water mass direction did not know and also lack of continuous and systematical database to support and increase correct knowledge and understanding regarding the tide and wave system both time and geography basis then it causes problems to the water management in mouth of the streams.

Therefore, the Office of Permanent Secretary of Science and Technology has been assigned to take responsibility Coastal Radar of Land and Sea Disaster Warning Development project by the Office of Geo-Informatics and Space Technology Development Agency (Public Organization): GISTDA is an organization established to implement the Coast Radar system installation to check and measure the tide and waves in Real time in order to get the information by installing total 18 stations in the gulf of Thailand, the data collection of each station will cover 60 Km from the coast with the data resolution per a point of 2 Km and the covering areas have been divided into 3 zones ; the upper part of the gulf of Thailand (Chonburi-Prachuab Kirikhan), the central part of the gulf of Thailand (Chumporn-Suratthani) and the lower part of the gulf of Thailand (Nakhonsithamrat – Songkhla).

The data derived from coastal radar system consists of information regarding direction, tide speed and wave height which can be applied to use for an oceanology such as environment reservation and water management, disaster warning, public disaster relief and tourism promotion, fisheries such as sea resource reservation and natural resources, pollution control and sea guard, meteorology and weather forecast (Jack H.,et.al.2010,2012)

The situation affecting the area of the gulf of Thailand besides coast erosion there are also the case of water pollution such as the oil leaks or illegal release into the sea which likely affect the sea resources and people making a living in aquatic animal culture area. Statistics of oil leak occurred in Thailand during B.E. 2516-2554 total 215 times

both at seaside, river and canal and the coastal areas such Rayong, Chonburi, Chacheongsao, Samutprakan, Bangkok Metropolitan, Chumpornm, Nakhonsithammarat, Songkhla, Pang-Nga, Phuket, Krabi and Satoon province. (Department of Sea and Coastal Resources, 2556) and during B.E. 2555-2557 the similar situation occurred for more than 10 times in Chumporn, Rayong, Chonburi and Samutsakhon province.

The cause of oil leak in the sea and the coast are 1. Oil leak in industrial zones, Laemchabang industrial estate in Chonburi province as a seaport and warehouse including the middle size industry and Mabtapud industrial estate in Rayong province as a location of the natural gas factory, Oil refineries, Petrochemical factory and from the oil drilling, oil transportation, navigation entry and out of the ferry. 2. Tar ball stains occurred from the oil release into the sea from cleaning activities of the ship and all types of boat without water treatment such as all size of ships, fishery boat and tourism boat, it had been brown and mixed by tide and wind to make it become an oil-soil at many tourism beaches. Due to many events of oil leaks in Thailand, so follow up and gain of its movement direction is very important and it must be completed in time and immediate for its collect and restoration, prevention before it comes to the coast or any sensitive areas, this is in order to reduce effects and damages probably occurred against natural resources.

Geographic Information technology can be effectively applied to use to follow up the resources changes by Alireza Taravat and Fabio Del Frate.2012 by using a technique of color mixture in appropriate wave range to able separate differences between the oily surface and water and by using the satellite images of MODIS, MERIS, Landsat-7 in Arabia gulf which able to separate difference of the oil leaks and the oil stains from plankton bloom which is suitable to be applied in a shallow area nearby the estuary (Zhao J, Temimi M, Ghedira H, Hu C.2014).

In addition the incidence of crude oil leak in the oil transfer point in the sea far from Marbtapud deep seaport around 18-20 Km. on July 27, 2556 and follow it by using satellite images RADARSAT2 in ScanSAR system : Narrow with image resolution 60 meters together with data from the coast radar system in Rayong province which giving a high accuracy of analysis result of the oil stain movement direction (the Office of Geo-Informatics and Space Technology Development Agency (Public Organization) 2556). Therefore, researcher had continuously followed up the situation regarding the oil leaks whereas upon a notice of a crude oil ship collapse at Parkklongpramong estuary in Samutsongkram province on April 7, 2557 far from the coast around 5.2 Km which in the data of such coast radar system therefore this case has been analyzed, studied and researched with hope to have a part of information notice to some agents in charge to be able to proceed the oil stains collect or give a warning notice to the people living nearby promptly.

## 2. Objectives

To apply the satellite images together with data from the coastal radar system to monitor the oil spill event in the coastal zone.

## 3. Area study

Study area is located in Parklongpramong river-mouth area, Pantainorasing sub-district, Samutsakhon province.

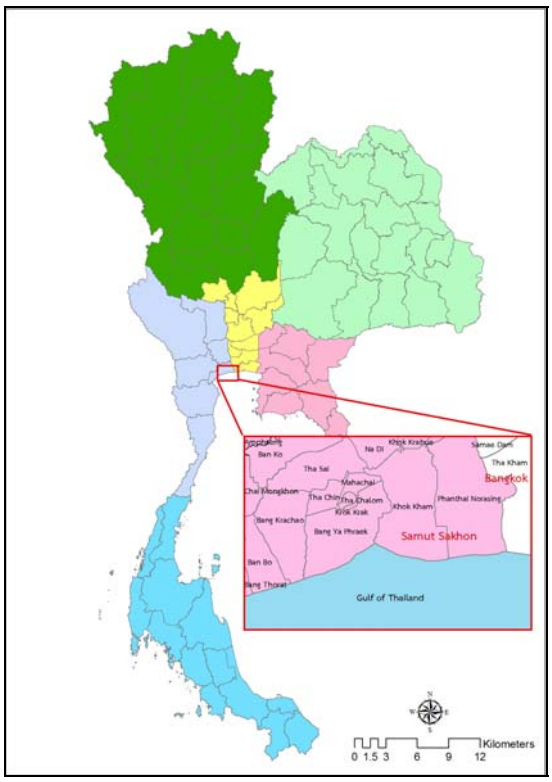


Fig. 1. Study area was affected from oil spill.

## 4. Implementation method

4.1 To investigate the satellite images data recorded in the study area on April 7, 2557 by selecting the images with clouds less than 20 percent.

4.2 Pre-processing of Landsat-8 in Multispectral system and the technique of color mixture and the image data focus.

4.3 Image processing to analyze for oil stained area with method of supervised classification in maximum likelihood type to find the scope of oil stain.

4.4 Comparison of accuracy with Error matrix method.

4.5 To build a model of the oil stain movement from the coast radar data during April 7-9 2557 with a Sea drift movement model by using the data coordinate and scope gained from such image analysis to set a model of oil stain movement direction.

4.6 To build a map guiding the movement way of the oil stains on Landsat-8

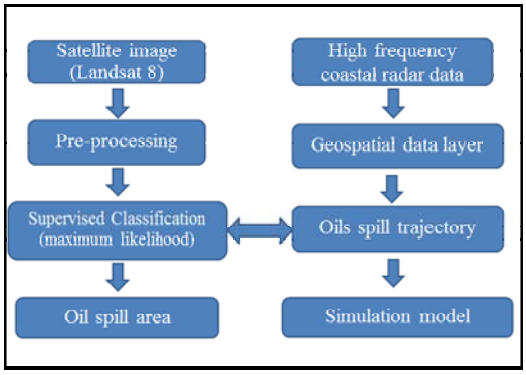


Fig. 2. Processing methodology

**5. Result and discussion**

The study found that upon False Color mixture : 7,6,4 and stressing on Histograms Equalize expressing the clearest spot of oil stains (image 3 and 4) and later proving an analysis with Supervise classification of maximum likelihood type and checking the data accuracy by using data coordinate of the oil stains spot which gained from a local agent and the fishermen and get analysis accuracy result at 82% whereas the area of oil stains at 10.00 O'clock spreading over 0.34 Km and the oil stains moved forwards to the North from the incident point for about 3.5 Km.

Fig. 3. Shows the images from Landsat-8 upon False Color composite: 4, 3, 2. It is difficult to separate the oil stained area from the sea water with dregs.

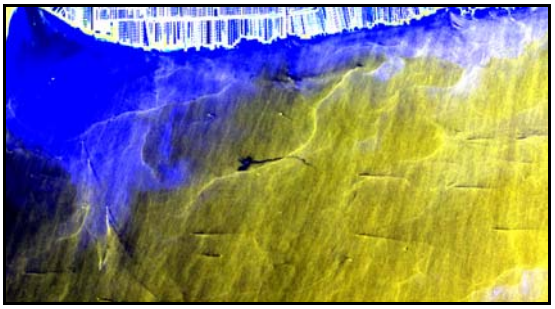

Fig. 4. Shows the images from Landsat-8 upon False Color composite: 7, 6, 4. It is able to show the area of oil stains clearly. (An area in a red frame).

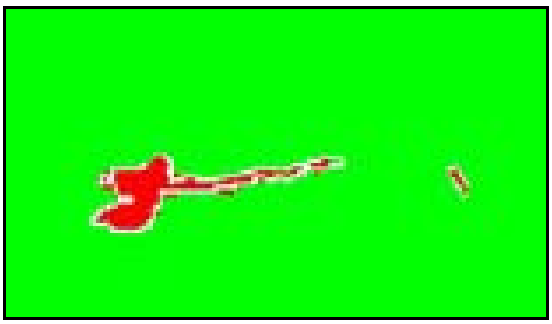

Fig. 5. Shows the result classifying areas with oil stains from the sea water with supervised classification method in a red frame in image 4 showing a red area as the representative of the oil stained area and the green area as the water sea representative.

The result from the oil movement model derived from the coast radar system found that the tide movement during 7-9 April 2557 at the collapse point of bulker oil ship in 2 directions as follows:

5.1 Movement form towards the North-South, the tide moved to the North (onshore) during 17.00-04.00 on 7-8 April with speed 20-30 cm / sec and move towards the South (offshore) during 06.00-16.00 o'clock on 8-9 April with speed 10-20 cm/sec so it caused the coast area Parkklongpramong and the coast area of mangrove nearby affected with such oil stains.

5.2 Movement form towards the East –the West, the movement in the South-east during a shot time 2-4 hours before change its direction from the North into the South and moved towards the South-North in a short time 2-4 hours during its direction change from the South into the North with speed not over 10 cm/sec.

The result of the oil stain movement has a radius about 5 Km. One of the oil stain portion moving onshore in the coast area Parkklongpramong and the mangrove coastline nearby.

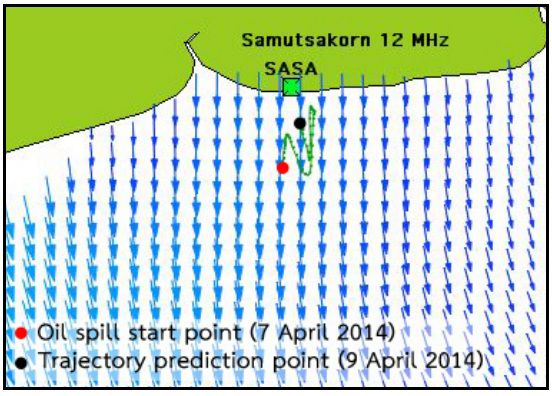


Fig. 6. Shows the movement model of the oil stains during 7-9 April 2557 with a program for Sea drift movement model.


Fig. 7. Shows direction of the oil stain movement on Lansat-8

## 6. Conclusion

Application of Landsat-8 for study together with tide data gained from the coast radar system to follow up the movement direction of the oil stains in case of the bunker oil ship collapse in Parkloangpramong estuary, Samutsakhon province on 7 April 2557 shown that the information of the oil stain scope get from the satellite image resulted in a specifying the start point of oil leaks in a process of the sea drift movement model with the Sea drift movement model program and it can get more accuracy of the movement direction of such oil stains or sea drift. Besides, there are other influences such as direction and wind speed, influence of rising tide and ebb tide and the location depth to be concerned. The data and information gained from this research has been continuously distributed to persons in charge for the most benefits of the collection and warning planning to people living the area in order to prevent any possible loses and damages to themselves.

## 7. Recommendation

The follow up of oil leaks or any illegal oil release into the sea has been difficultly performed. An important information are the coordinate of geographic data and an explicit occurrence time clear which shall support and give more accuracy to some data analysis regarding the oil stain movement direction by applying the geography information and the coast radar system data or its movement direction model with other means. The result gained from the study shall support the concerning persons in planning for collection and recover of the oil stains and Seadrift to be able to use this data for application for the effects reduction to resources, environment and people. At the same time the implementation for this problem resolve must be coordinated and exchanged with data and information from all sectors in order to precede the problem resolve quickly and reduce the effects against the area nearby.

## 8. References

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