INNOVATIVE CONTROL AND MONITORING TECHNIQUES FOR ENHANCING PHYSICAL FACTORS OF SEA SALT PRODUCTION IN SAMUT SONGKHRAM PROVINCE

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Abstract

The first objective of this study was to analyze the water source that has been used to produce salt from the seaside to the final product (salt) and give the proper planning with the help of geographic information technology(system). Furthermore, the study tried to find a better strategy to control and monitor the water quality in different positions of the salt farms.The second objective of the study was to produce high-quality salt according to the agricultural standard. The introduced system would be in accordance with the local farmer's practices andinformation. The research was conducted in the salt farm of Bang Kaeo Subdistrict, Mueang District, Samut Songkhram province.

The research was conducted based on communication with farmers verbally as well asscientific survey to find the specific research problem directly or from farmers union. The solution was introduced based on latitude and longitude positions in different parts of the salt farm, analyzing the factors involved in the water quality and introducing the online innovatedsystem as the online water quality analyzer. Furthermore, the water samples were collected, and specific factors (elements) were analyzed in the lab. Finally, the quality of the salt producedby farmers is scientifically controlled. The results found three factors involved in salt production, quality of water, changing the climate annually and local expertise and techniques.The specific factors of water quality were pH (7.6-7.8), DO (4.4-7.7mg/l), Salinity (24.26- 29.60ppt.), Pb (8.82-11.85 ppm), Cd (1.15-1.60ppm) and Cu (0.1-0.7 ppm). Mercury and arsenic weren't detected in the water. Annually, in April the salt index was slightly increased (28.5-30.7 ppt.). Overall, the natural sea salt had the quality in accordance with the THAI AGRICULTURAL STANDARD TAS 8402-2019. From the geography point of view this study showed that these two areas were suitable for producing the natural sea salt.

In conclusion, the process and the techniques of local farmers would produce the highquality of sea salt according to Thai agricultural production. They should be concerned about monitoring the quality of water continuously.

Keywords: Geoinformatics technology, Innovative monitor, Sea salt, Samutsongkram.

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Introduction

Sea salt production in Thailand is mainly found in the area of the inner Gulf includingSamut Sakhon, Samut Songkhram and Phetchaburi Provinces.Producing sea salt are usually base on the traditional method. The total production of sea salt in the country is about 900,000tons (Department of Cooperative Promotion, 2020). The process usually starts at the end of the rainy season around October or November till mid-May of the next year. Thus, sea salt production is about 6-7 months, depending on the weather. Currently, there is no new technology involved in sea salt production. Usually, farmers used their traditional practices that they have learnt from ancestors. in traditional method simple tools is used to form the saltponds. This man-made pools and ponds flooding with the sea water and waiting that water evaporate under the sun and the sea salt crystals participate. The traditional salt production mentioned in 3 provinces started with pumping sea water with 30-40ppt salinity after removingthe contaminants from the water, the water pushes to the next station, Na Tak, that with the help of sunlight and wind evaporation happens, then in the next area calcium sulfate participates. The last station and pond is the place of salt crystallization.

Specific gravity in different station and its measurements are the main and important task that the farmers learned from their ancestors. The aforementioned salt production process causes the production of Thai sea salt cannot achieve the acceptable standards comparable tothose used in the industry (Thai Industrial Standards, Refined edible salt TIS. 2086 - 2544).Inparticular, compounds of iodide of the dried mass shall not be less than 20 and not more than 40 mg/kg. (Notification of the Ministry of Industry, 2013) and For the National Agricultural Commodity and Food Standards, the toxic contaminants shall not be found more than 1.0 , 0.5, 0.5 , 0.1 and 2.0 mg/kg of metal substances such as lead, cadmium, arsenic, mercury and copper respectively (TAS 8402-2562 Agricultural Standards).

Currently, the price of salt is about 2.50 baht per kilogram, which is considered a veryl o w p r i c e . Therefore, there can be done many to produce better quality salt based on thedesirable standard. It should mention here that low quality of salt is mostly related to the environmental and soil physical factors and water quality.

Nowadays, it's absolutely necessary to find the better way to develop salt production with higher standard therefore the need to educate the participations from all relevant sectors,especially framers and introduce them with more advance and precise method is inevitable in the development and promotion of sea salt production. One important method of analyzing that would have potential in salt production is application of geoinformatics data, the technology to obtain physical data for spatial management.

Therefor by applying this technology in particular with the help of geographical characteristics of the areas clear information about the soil and water route would be achievedand there effects on the quality of final salt products can estimate. Thus, the aim of this researchis to apply the geographical study of different areas that sea water passes in Samut Songkhramprovince before arriving at the final destination of salt production and their effect on the qualityof final salt product. The data provided in this research can be saved as the environmental management data of salt farming in Samut Songkhram Province.therefore our study includes the application of new technology to monitor water quality from the sea to salt final product. The application of this data in the production also would discuss. The applicability of differentequipment to gain the data and analyzing of the data towards application also reviewed. To achieve the goal of this project researcher found suitable zone areas to conduct the research, this includes the innovative method to monitoring the water quality for faster precipitation.

Objectives of the research

1. To analyze water quality factors that affect the production of quality sea salt inSamut Songkhram Province

2. To analyze the level of suitability in sea salt production by spatial zoning methodusing geographic information system Samut Songkhram Province

Research methodology

The research was conducted practically in the area of Bang Kaeo Subdistrict, Mueang District, Samut Songkhram Province. with the following steps:

1. Creation of participatory processes in research through organizing meetings with the Salt Farmers' Federation(salt farmers in Bang Kaeo Sub-district area,) and with surveying and collecting data fromwith analyzing the database of basic factors related to sea salt production

2. Collect water quality samples in the area. analyze the following parameters: Pace, color, salinity , sodium chloride content and heavy metal content (lead, cadmium, mercury, arsenic and copper) in the watershed area where farmers produce salt. These areas are the entrance to Pak Map Canal, Muen Han Canal, Khet Mueang Canal and Bang Bo Canal.

Water samples were collected in 2 times periods, before pumping water to reservoir pond (October - November) and after salt collection (April-May) selection of salt farming areas (Pak Map Canal, Muen Han Canal, Khet Muang Canal and Bang Bo Canal) to study thechanges in route of water quality in the salt production system.

Water samples were collected in 4 wells, namely reservoir pond, sun drying pond, saltseeding pond and salt precipitating pond. The analysis of 12 main parameters affecting salt production including salinity level specific gravity, pace, color, temperature, sodium chloride content and amount of calcium sulfate Heavy metal content (lead, cadmium, mercury, arsenicand copper). Samples were collected at two intervals, 1 month after pumping water into reservoir pond and 15 days before salt collection.

Analyze and find specific guidelines by selecting new technology in water quality monitoring that can be applied in selecting the source of water quality. This was carried out atleast 2 times during the research , consisting of a period after knowing the results of the source water quality during each month's salt farming and before salt storage.

3. Analyze the quality of salt produced according to Thai sea salt standards. (TAS 8402-2562, 10 parameters) and salt standards for consumption (TIS 2086 -2544 , 8 parameters)

4. Study of salt fields in Samut Songkhram province by using remote sensing technology from satellite image data. By interpreting land use and land cover from sentinel-2 satellite image data in the area of Samut Songkhram Province in 2016 and 2021 through Google Earth Engine , which has a level 3 land use dataset of the land development.

5. Take the results of land use classification and land cover in the model area with images from the Sentinel- 2 satellite in 2021, showing the results of the preparation in the form of land cover and land use maps. land And spatial data in the form of GIS data that can be used to analyze various data spatially and create a zoning map to divide potential areas for sea salt production.

Research results

Quality factors on sea salt production in the area Samut Songkhram: It was found that salt farmers choose to use water sources from canals that connect from the coastal sea through4 main canals, consisting of Muen Han Canal, Pak Map Canal, Khet Mueang Canal, and BangBo Canal.

The main factors affecting the salt production in the area of Bang Kaeo sub-district: The results obtained from the analysis and discussion with the salt farmers consisted of 3 aspects: the quality of raw water each year; climate change from year to year and control of salt production techniques based on local knowledge. Each factor is equally important and thewater quality analysis results are shown in Table 1-4.

Table 1: Analysis results of water quality in the main canal for salt farms in November 2021 (water preparation period for salt farms)

Sampling location	coordinates		water quality								
	latitude	longitude	pH	DO (ppm)	Salanity (ppt)	NaCl (ppm)	Pb (ppm)	Cd (ppm)	Cu (ppm)	Hg (ppm)	As (ppm)
Muenhan Canal	13.20 . 843 N.	099.53 . 439 E	7.82	7.70	29.10	2210	8.82	1.15	0.10	ND	ND
Khlong Bang Bo	13.23.205N	100.02.336 E	7.60	5.20	27.90	5424	11.85	1.77	0.42	ND	ND
Pak Map Canal	13.23.205N	100.02.175 E	7.60	5.80	24.20	5698	10.37	1.25	0.60	ND	ND
urban canal	13.25.543N	100.04.717 E	7.82	4.40	29.60	7598	11.60	1.80	0.70	ND	ND

Table 2: Results of water quality analysis in the main canal for salt farming during April 2022 (salt harvesting period)

Sampling location	coordinates		water quality								
	latitude	longitude	pH	DO (ppm)	Salanity (ppt)	NaCl (ppm)	Pb (ppm)	Cd (ppm)	Cu (ppm)	Hg (ppm)	As (ppm)
Muenhan Canal	13.20 . 843 N.	099.53 . 439 E	7. 51	6.52	30.21	2300	7.21	1. 21	0.1 5	ND	ND
Khlong Bang Bo	13.23.205N	100.02.336E	7.6 5	5.36	29.56	9200	10.25	1. 56	0.4 5	ND	ND
Pak Map Canal	13.23.205N	100.02.175E	7.6 2	5.42	28.51	5550	9.25	1. 58	0. 46	ND	ND
urban canal	13.25.543N	100.04.717E	7.8 8	4.4 5	28.96	8570	1 0.56	1. 55	0. 54	ND	ND

Table 3: Analysis results of average water quality in salt fields throughout the production period in 2022

Sampling location	water uality											
	pH	Temp (ºC)	Color (ADMI)	Salanity(ppt)	NaCl (ppm)	Sulphateppm)	Pb (ppm)	Cd (ppm)	Cu (ppm)	Hg (ppm)	As (ppm)	Mg (ppm)
Reservoir pond	9.14	29.3	130.29	42.40	60,000	2,7025.95	5.52	0.32	1.10	ND	ND	36.82
Sun drying pond	8.94	29.3	152.48	57.60	21,250	8,447.26	5.95	0.62	1.20	ND	ND	38.00
Seeding pond	7.25	29.4	300.74	112.50	5,250	761.77	9.77	0.25	1.25	ND	ND	46.22
Salt setting pond	6.46	28.9	347.65	181.60	1,250	687.09	5.42	0.57	1.50	ND	ND	55.37

Table 4: Results of salt quality analysis from November 2021 to July 2022

sample type	salt uality										
	Ca (g/kg)	Fe (mg/kg)	NaCl (g/100g)	SO 4 (g/kg)	Pb (mg/kg)	Cd (mg/kg)	Cu (mg/kg)	Hg (mg/kg)	As mg/kg)	Moisture (g/100g)	Insoluble Matter(g/100g)
white salt	0.520	8.33	98.39	1.396	1.38	ND	ND	ND	ND	4.64	0.02
TIS. 2086 – 2001	0.40	50.0	97.0	0.70	<2.0	<0.5	<0.2	<0.1	<0.5	<7.0	<0.5

Table 1-4 shows the quality of water for raw water sources in Bang Kaeo Subdistrict. There are 4 main canals used to produce salt. It was found that during November of every year, water quality consisted of pH (7.6-7.8) , DO (4.4-7.7 mg/l), Salinity (24.26-29.60 ppt.), Pb (8.82-11.85 ppm), Cd (1.15-1.60ppm) and Cu (0.1- 0.7 ppm), and mercury and arsenic were not found.

During April, it was found that the water had salinity (28.5-30.7 ppt) and heavy metalssuch as lead, cadmium, and copper. They were found to be the highest at the entrance of the urban canal in relatively compared to seawater quality standards (according to the announcement of the National Environment Board Regarding setting standards for sea water quality, 2021).

The analysis of the average water quality in the salt fields throughout the salt production period in 2022 found that the amount of metal substances in the clarifiers decreased not much from the sun drying pond, salt seeding pond and precipitating pond. the results of the salt product analysis showed that the heavy metal content in the category of leadwas not higher than the standard. 8402/2562 (less than 2.0 grams per kilogram), other heavy metals did not find in salt products.

Therefore, it is necessary to develop production process water quality control And cleaning the salt to reduce the amount of contaminants.

Results of Geo-informatics geospatial management for salt production based on indigenous knowledge: in Samut Songkhram Province, using the input factors to analyze the potential zone, consisting of the distance from important resources such as estuaries, canals, mangrove forests, and the distance from potential sources of pollution such as industrial factoriesor community areas (that may cause activities that affect water quality to salt production). It was found 3 levels of potential areas and shown by a map as in Figure 1, namely

Level 1 refers to a salt producing area with very good potential.

Level 2 refers to salt producing areas with good potential.

Level 3 refers to salt producing areas with medium potential.

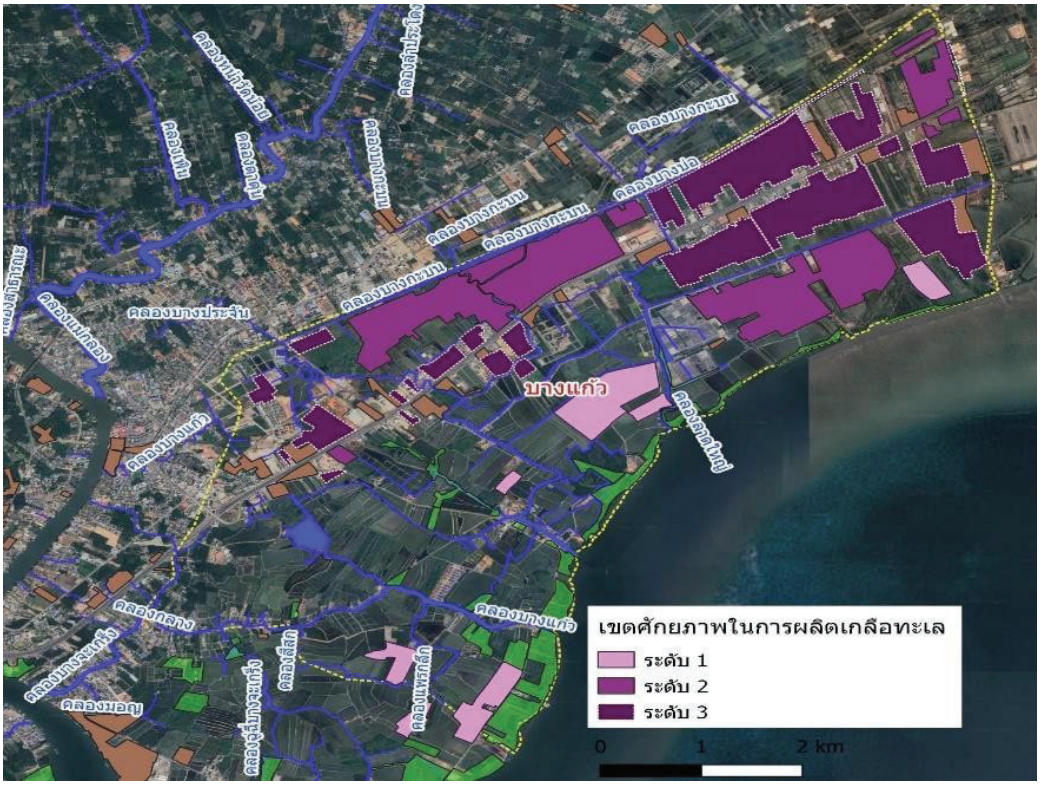

Figure 1: Map of the sea salt production potential zone, Bang Kaew Subdistrict, Mueang District SamutSongkhram Province

Results of the study found ways to apply new technology for water quality monitoring:It was found that the area of Bang Kaeo sub-district was able to produce quality salt accordingto the standards of agricultural products. TAS 8402/2019 by using information that has been passed down from generation to generation and from taking traditional lessons and monitor changes in water quality. It was found that farmers were very interested in and want to have the introduction of modern technology in checking water quality and alerts for more timely manner. the study found online alerts can be applied as the new technology to inform the members (farmers) about the water quality derived from different kind of sensors.

Summary and Discussion

There are three main factors affecting quality salt production: The quality of water thatis the source of raw water that farmers in the area of Bang Kaeo sub-district used to produce salt. climate (change from year to year) and the process of producing the salt which is based traditional information on control of salt production .Each factor is equally important, which is consistent with the results of the study by Juthamas (2020). There is an additional differencein the salt production control technique that can be applied to the current technology. according to Trowbridge *et al*. (2016) contaminants found in raw water sources in each canal had a low effect on the quality of salt produced. This is consistent with the results of a study on chemical precipitation in salt fields by Fengmin *et al*. (2018).

They showed that the production process can reduce the amount of heavy metals fromthe preparation of the clarifier and in the crystallization process of sodium chloride however in some seasons, it was found that there was a small amount of contaminated heavy metals (higher than the TAS 8402/2562 standard). from the results of the salt quality analysis over a period of 5 years, from 2018 to 2022, water quality may affect the natural sea salt production process without proper control of the salt crystallization process, As for the study of salt fields in Samut Songkhram Province using remote sensing technology from satellite image data. It can be concluded that the area in Tambon Bang Kaeo There is a very good potential for land utilization for sea salt production in Samut Songkhram Province. This is consistent with the research results of Jutamas (2021), and research results of Chaisri & Witthaya (2020).

In Summary to monitor factors affecting sea salt production in the area, an integration of online water quality monitoring technology with analysis of water quality from sensors canbe better practices.

Suggestion

In this research, the primary relationship between water quality and salt quality wasstudied. This requires regular data collection on salt quality factors.

It is necessary to develop a salt production process in conjunction with appropriate application of technology to achieve surveillance every year.

More research is needed in the development of better quality salt production technology that meets the market demand in every sector in order to help farmers achieve career stability in the future.

There should be a work plan in the form of workshop to jointly find ways/strategies for sustainable salt productionwith the help of farmers of agencies in different areas.

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