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Objective and Subjective Factors Influence on Demand of Drainage by Pumping in Red River Delta

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Abstract. The demand for newly constructing of drainage pumping station in Red river delta has increased recently. Total drainage volume for the whole region in 2006 was 2406.8m^3/s, and it was predicted to increase to 5181.3m^3/s in 2020 [1]. The average drainage coefficient for the year from 2010 to 2020 will be 7.0 l/s per hectar, three and a haft time higher than the average drainage coefficient for the period from 1954 to 1973; 1.8 times higher than 1973 to 1976 and 1.3 times higher than 1976 to 2000. This article aims to provide the primary analysis of objective (drainage requirement) and subjective factors (socio-economic condition, psychology, information, etc) influencing on the demand of drainage. The out come shows that the draingae demand seems to be impacted by subjective factors rather than objective ones.

1. Introduction

Since 1954 Government had paid a lot of attention on drainage in Red river delta. This attention has increased recently. The scale of drainage struture very much depends on drainage coefficient which is calculated based on drainage unit on area unit (l/s-ha). Through water resources planning, the drainage coefficient has been increased, from 1954 to 1973, the drainage ratio in region was 2.03l/s-ha; from 1973 to 1976 it was 3.89 l/s-ha; and from 1976 to 2000 it was 5.32 l/s-ha; During the period from 2010 to 2020, the drainage coefficient was predicted from 6.88 l/s-ha to 6.90 l/s-ha. There are a number of drainage pumping stations which were designed at the drainage coefficient of 12.50 l/s-ha.

In regards to drainage service area, the master plan developed by Institute for Water Resources Planning shows that the drainage requirement area for 2010 based on sustainable senerior is 1,116,559 hectar [1]. Of which drainage by pump serves for 731,432 hectars (taking approximatly 63%) and gravity drainage takes 435,127 hectars (taking 37%).

Based on the drainage requirement, Ministry of Agriculture and Rural Development (MARD) issued the list of investment for the duration from 2011 to 2015, document 3505/BNN-KH on 28 October 2009, which included thirty six projects with the total proposed investment of 14,043 billion VND. Among this list, there were 29 projects on drainage. Regarding new construction of pumping stations, within sixteen projects there were only two irrigation pumping station projects, fourteen projects were constructing of drainage pumping station. Total investment for newly constructing of sixteen pumping station was 5,425 billion VND, of which 5,105 billion VND was the cost for fourteen drainage pumping station projects (taking 94%). This

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number shows the necessity of new construction of drainage pumping station in near future, as well as indicates the important role of drainage in developing the irrigation and drainage system in Red river delta.

In order to investigate the main reason for increasing in the requirement for more drainage pumping station, this article will examine the objective and subjective factors which impacting on drainage requirement as well as find out the appropriate attitude for drainage.

2. Objective factors

Objective factor impacting on drainage requirement is intensive rainfall. Through analyzing the changes in rainfall statistics, the objective factors on drainage and drainage solution will be examined. The analysis of pumping drainage has been studied in 7 meteorology stations including Hai Duong, Hung Yen, Ha Dong, Ha Nam, Nam Dinh, Ninh Binh and Thai Binh. The statistical daily rainfall data from 1976 to 2008 [2] for Phu Ly station has been used for illustrating the 1, 3, 5, and 7 days of the maximum intensive rainfall and the total rainfall at those stations (figure 1). The rainfall data for other stations in Red river delta is also demonstrated, and the evaluation as below

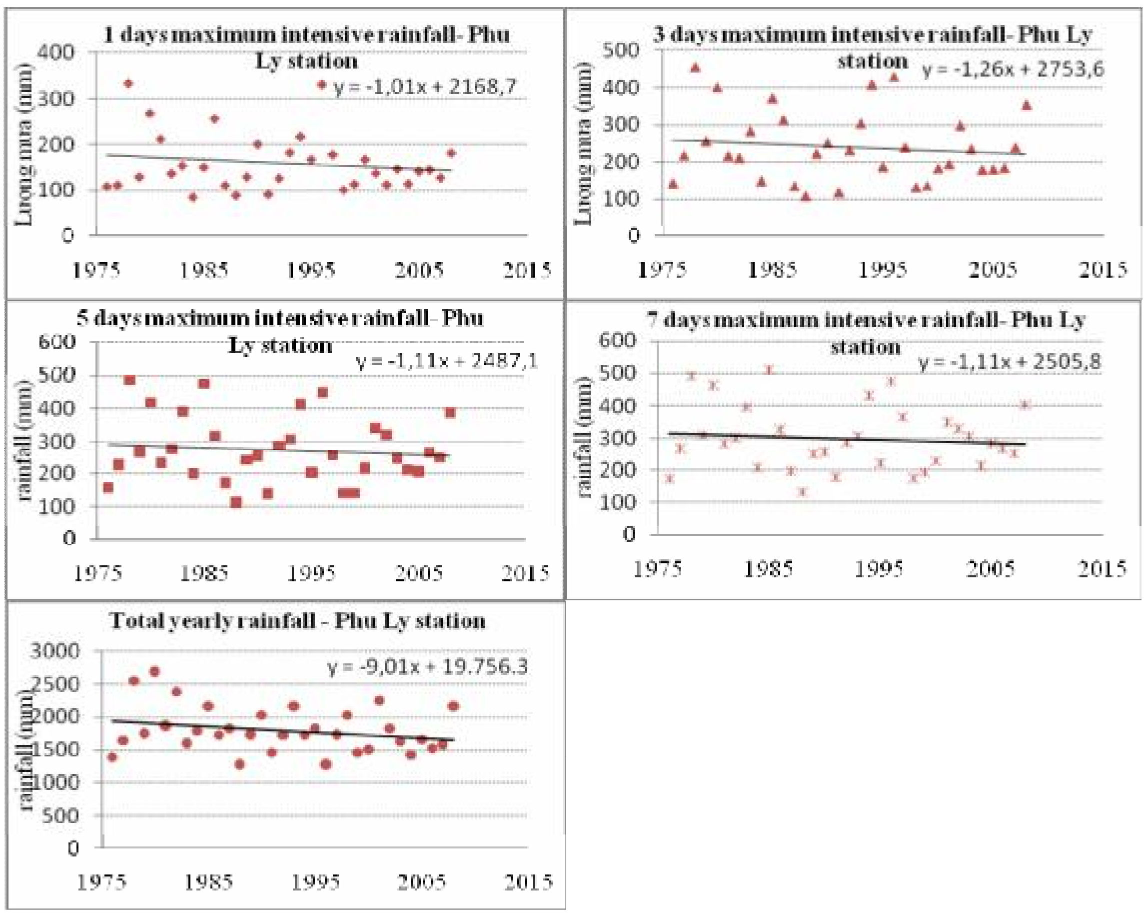

Figure 1. Example of the 1, 3, 5, and 7 days maximum intensive rainfall and total rainfall at Phu ly meteorolofy station.

- One day maximum intensive rainfall seems to reduce, especially in Nam Dinh meteorology station the rainfall has been avaragely decrease 3.5 mm/year during 33 years of recording. Others seven meteorology stations also have the same trend as Nam Dinh station. The statistical data for Ha Dong metrorology station shows a particular point of intensive rainfall in November 2008 due to over intensive rainfall on that year.

- In regards to three days maximum intensive rainfall, five among seven meteorology stations including Nam Dinh, Thai Binh, Ninh Binh, Phu Ly and Hung Yen seem to have a reduction in rainfall from 0.6 mm to 3.7 mm/year. There is only Hai Duong station showing the increase in three day maximum intensive rainfall, but it is negligible, only 0.6 mm/year. Regarding Ha Dong station, althought it has been showed the increasing trend, it was just an impact of historical rainfall in November 2008. If the figure is only presented for Ha Dong station by 2007, it also shows the reduction trend as same as other meteorology stations.

- Regarding five day maximum intensive rainfall, five within seven meteorology stations show the reduction trend. The remarkable reduction can be seen in Nam Dinh and Hung Yen meteorology station, decreasing from 3.6 to 3.7 mm/year. There was no change in Hai Duong meteorology station. The figure of Ha Dong station seems to have the increasing trend but it was because of historical rainfall in November 2010

- Concerning seven day maximum intensive rainfall, five among seven meteorology stations show the reduction trend of about 3 mm/year. The figure of Ha Duong station shows no changes. The figure of Ha Dong station seems to have the increasing trend but it was because of historical rainfall in November 2010

- The total rainfall which was measured at five among sevem meteorology stations seems to decrease. The most reduction can be seen in Hung Yen station in about 12mm/year. Nam Dinh, Thai Binh, Phu Ly and Ninh Binh stations have the reduction from 9 mm/ year to 10 mm/year. The figure of Ha Duong seems to be stable. Ha Dong station has a trend of increasing but this trend influenced by historical rainfall in November 2008.

- In regards to characteristic of intensive rainfall, it seems almost 1, 3, 5, or 7 days of intensive rainfall often happened in the long period of rain. This issue brings the nagative impact on rainfall model simulation.

Analyzing the rainfall changes and trend shows that the comparison of increasing in drainage coefficient and drainage rainfall seems to contradict. This contradiction can be explaned as following

- Previously, the TCVN 285-2002 and TCVN 5090 and other regulations regulated that the drainage capacity in responding for rainfall frequency of about 10 to 20%. Due to difficulties in economy, the drainage capacity could be selected at the rainfall frequency of 12%, 15% and event 20%. Nowadays, almost of all planning and design often based on the rainfall frequency of 10%.

- Design drainage coefficient also depends on drainage model. In the past, because of economic condition, the planner could be based on rainfall model with fewer disadvantages in order to reduce the design drainage coefficient.

Analyzing the changes in drainage of intensive rainfall and factors impact on drainage requirement and shows that rainfall seems not to be an objective factor. Socio-economic, changing in cropping pattern or other factors might be the subjective factors impacting on drainage requirement.

In addition, due to topography characteristics of Red river basin slopes from Northwest to Southeast, particularly the delta is in the pan shape topography with the higher elevation land located along the river bank and deep valley is located on cultivated farm, these conditons have nagative impacted on drainage actitities, especially the central delta where drainage by tide has been not in practice. Therefore, the drainage pumping stations are often located in the Red river delta such as North Nam Ha, and Southwest of Nhue river system.

3. Prediction factors on climate change impact on drainage solutions

There are two main drainage solutions in Red river delta which including pumping and gravity. Gravity drainage takes small percentage (below 30%) concentrating on coastal zone areas. This drainage solution makes used of ebbing tide for drainage. In which, among 297,600 hectares of full gravity drainage in the region [3], there are 279,300 hectares (taking 94%), located along coastal zone in South and North of Thai Binh province, central and South of Nam Dinh province, as well as Hai Phong.

Climate change scenario, and sea water rise for Vietnam has been developed by Ministry of Natural Resources and Environment which was declared in June 2009 indicating:

- According to low emission scenario, rainfall in Red river delta and Thai Binh river basin will increase 5%, while rainfall from March to May will reduce from 3% to 6%. In medium greenhouse gas emission, rainfall in Red river delta will increase up to 10%, and rainfall from March to May will decrease from 6% to 9%. Therefore, rainfall in rainy season will remarkably increase which pressing on the drainage demand. Particularly, it was predicted that during the period from 2010 to 2020 and 2030, rainfall in Red river delta region will increase by 1.6% to 2.3% in comparison to the time from 1980 to 1999.

- In regards to low emission, medium emission (B2) and high emission scenario (A1F1) , sea level rise will increase by 0.65 m, 0.75 m and 1.0 m respectively at the end of this century. From 2020 to 2030, it was predicted , sea level is projected increasing from 12 to 17 cm.

- The combination of rainfall and sea level rise will narrow down the gravity drainage area in coastal zone in the North. A large area will be inundated and semi-inundated. According to Prof Dr Dao Xuan Hoc [4] pointed out that the inundated area in Red river delta will increase to 550,000 hectares, 650,000 hecrares if sea level rises up to 0.69 m and 1.00 m respectively. In addition, the river level will rise at the average level from 0.5 m to 1.0 m, exceed alert 3. That means the water level in river nearly approaches high crest of current dike. If sea level rises up to 0.69 m, the area in Red river delta with the elevation is below 0.8 m (133,221 hectares) will be inundated, the area with the elevation is higher than 2.2 m (300,319 hectares) will be semi-inundated; If sea level rises up to 1m, the complete inundated area below 1.5 m will be 181,917 hectares, and semi-inundated area with the elevation below 2.5 m will be 365,431 hectares.

Climate change and sea level rise in any scenerios always bring the strong impact on drainage solutions, therefore drainage by pump seems to be the only one solution for Red river delta in the future

4. Impact of socio-economic development on drainage requirement

Economic development is related to the process of development, construction, upgrade, and comprehension of infrastructure and the changing of land use. Base on the research of rainfall-runoff, drainage is affected by surface area.

The research of rainfall- runoff is showed the lost volume on the surface of hydraulic structure by waterproof material which is tiny. The rate of rigid surface increase which is opposite with the loss of water therefore it is danger of the amount of drained water and describing by run-off coefficient.

The conception of run-off coefficient is calculated by the ratio between suface water (mm) by rainfall and the amount of water (mm) σRoff = Y/P, where: Y: run-off by rainfall; P: precipitation

In the developed countries, run-off coefficient is researched by the sceintiest of irrigation and drainage. After that, it will be determined the other surface factors in different areas, different regions, different crops. Meanwhile, the research in run-off coefficient in Vietnam which is too limited, even in textbook, guide book the run-off coefficient is copied from abroad research results.

Run-off coefficients of surface

Surface classification	Run-off coefficients σ_{Roff}	Surface classification	Run-off coefficients σ_{Roff}
Grass		Industrial zone	
- Sand, steep 2%	0.05-0.10	- density rarely	0.50-0.80
- Sandy loam, steep 2%	0.13-0.17	- density dense	0.60-0.90
Urban land	0.70-0.95	Amusement park	0.10-0.25
Rural land	0.50-0.70		0.20-0.35
Stone	0.70-0.85	Railway	0.20-0.40
Streetside	0.75-0.85	Concrete	0.70-0.95
Roof	0.75-0.95	Mặt bê tông	0.80-0.95

Source: AFTER CHOW, 1962

Obviously, run-off coefficient is on surface by infrastructure is compared with the other land use objects, especially over 90% rainfall will be a run-off on surface of cement, roof in case no water storage or other multi use which will have to drain.

In this case, the statistic of transportation in Red river delta show the density of national, provincial, districial highways is high, in range 0.5 km/km^2 [1], if the wide of road is 20m, the area will has 1% of total zone. Similarity, the density of village road is 1.81 km/km^2 [1], if the wide of road is 3m, the area will has 0.54% of total zone. The sup up of road will grow up to 1.54% (equal to 15,718 hectares). The area for transportation is huge, the plan for land use in 6 provinces in the central delta includes Bac Ninh, Ha Tay, Hai Duong, Hung Yen, Ha Nam and Nam Dinh [5] in 2005, the transportation area has 48,619 hectares, plan to 56,218 hectares in 2010, increase 7,599 hectares.

In the other, economic development will be incresingly land for industry used. Statistical data for Industry land used at 2005 in six provinces in central of the delta and Thai Binh province is 8,282 hectares, planning for 2010 will be predicted to 25,098 hectares, more than three time higher. The change of land used mostly form cultivation land and pond or lake land, that is one of big reasons to incresingly of darinage requirement because ron-off coefficient for the industry land used from 0.5 to 0.9, in other for the cultivation land run-off coefficient is only from 0.3 to 0.6 [6].

Urban land increased dramatically in 2005, 7 provinces in central delta has 8109 hectares urban land which would be increased to 14,290 hectares area in 2010, 1.76 times increasing. The cultivated land has been transferred into urban land, which is the main reason causing the demanding on drainage.

Rural land also increase many times which is also transferred from cultivated land. In 2005, 7 provinces had 69,996ha, planned to 74,748 hectares in 2010, increasing of 4752 hectares. Therefore the drainage demand will increase by run-off coefficient from 0.5 to 0.7 in rural land which reference from aboard document (note that the population density in Red river delta is 122,000 people in a square kilometre, may be higher than foreign countryside). It is much higher than the run-off coefficient in cultivated land [6].

The increasing in non cultivated land has been contradicted is opposited with the reduction area of lake, pond, stream and river. In 2005, 7 provinces in central delta had 61,482 hectares; however its plan has gone down to 58,064 hectares in 2010. Almost of 3418 hectares reduction is pond and lake which are water storage area and can be use to regulate rainfall, because the using purpose might be not changed from natural river and stream. There is information show that, In Hanoi capital city, 80% of water surface area has regulated capacity which has been leveling for construction for 50 years by a source.

In addition, the area for rice (which can regulate drain water) in some areas in central delta has dramatical fall to 386,641ha, 71,170ha mitigration which is significant number. If the rice area in Red river delta drecrese 40,700ha from 2000 to 2005 (report of MARD) and in 10 years, 2000 to 2010, there is at least 111,870ha rice area (10%) total natural area in this delta change to non agricultural purpose. The change of land use to non agricultural purpose is leading to the increase of drainage demand many times which is compared with rice land and cultivated land.

5. Discussion and recommenation

Obviously, all socio-economic indicators have been indicating land use planning in all provinces in Red river delta showing the objective fators for increasing the drainage demand. In the above analysis shows the rise of amount of drain, and the drainage capacity also increases by the drainage demand for incultivated land which is drained by day. There are 2 factors to increase the domain of area and which are the main causes in order to the increase of drainage coefficient demand. Throught out the analysis, again we are able to realize that the cause of increase drainage coefficient is by the subject factors than objective factors.

Beside the above analysis, there may be an impact which is media commucation. This impact influences in decision making process of decision makers. For example, the information is transferred quickly via media people and often does not purely reflect the actual situations. This strongly impacts on making the decision which consequently effects on planning of drainage system. The design parameters of the drainage system are affected by a series of factors therefore the consultants seem to choose the negative factors for designing which enable for easy approval. In order to mitigate these potential impacts, the government will need to have regular researches on monitoring and evaluation of drainage system. Findings from these researches will be the foundation for developing appropriate drainage system in order to minimize the investment cost and wasting rain water.

The analysis also show that the pumping drainage structures seem having bigger capacity which might increase by 2 times, reaching the capacity of 5181.3 m^3/s in coming 10 years. Hence, it is necessary to conduct the researches on appropriate solutions in order to upgrade and modernize the drainage pumping system in Red river delta. Especially, there is a particular need to find the proper solutions for on farm drainage, effective use of rainwater, against groundwater depletion and analyse effective investment to prove to the society the effect and necessity of investing on drainage structures.

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