



ASSESSMENTS OF CLIMATE CHANGE AND SEA LEVEL RISE IMPACTS ON FLOWS AND SALTWATER INTRUSION IN THE VU GIA - THU BON RIVER BASIN, VIETNAM

Nguyen Mai Dang¹, Le Ngoc Vien², Nguyen Bach Tung³,
Tran Anh Duong⁴ and Thanh Duc Dang⁵

ABSTRACT: In recent years, besides the impacts of socio-economic development activities, climate change (including changes in rainfall and sea level rise) in the Vu Gia - Thu Bon river basin has directly affected water source security in the basin. Floods, droughts, and saline intrusion become irregular and increasingly serious, greatly affecting the supply of irrigation water for agricultural production and domestic use in the basin. In this study, we used a mathematical model to simulate changing flow patterns and saline intrusion in the river system in response to different climate change scenarios. Our modelling results show that the annual flow and the dry season flow in the basin tend to decrease under the pathway RCP 8.5 in the future periods 2030-2050, and the distribution of the flow varies among simulation periods and climate change scenarios. Although future flows at the end of century tend to increase due to the impact of climate change, the simulated results show that saline intrusion also increases in all scenarios. Under the RCP 8.5 pathway, on the Vu Gia river, the salinity concentration isoline of 1 ‰ intrudes into the river from 19.7 to 20.1 km, and 4 ‰ saline isoline from 18.4 to 20.8 km. On the Thu Bon river, the salinity isoline of 1‰ enters into the river from 18.6 to 20.3 km, and from 16.7 - 18.5 km for the salinity isoline of 4 ‰. Our results will be a scientific basis for decision making agencies to identify appropriate development strategies to adapt and mitigate negative impacts of climate change to ensure sustainable development at the basin.

Keywords: Climate change, Sea level rise, Flows, Saline intrusion, Vu Gia - Thu Bon River Basin.

I. INTRODUCTION

The Vu Gia - Thu Bon river basin stretches from 14°57'10" to 16°03'50" North latitude, 107°12'50" to 108°44'20" East longitude with a major part located in Quang Nam province, Da Nang city and Kon Tum province (Fig. 1). The total catchment area is around 10,350 km². The lower basin has one of the largest socio-economic centers of the country, Da Nang City, two world cultural heritages (Hoi An Ancient Town and My Son Sanctuary), and the Cu Lao Cham Biosphere Reserve. At the lower basin, the two rivers connect to each other through the Quang Hue and Vinh Dien rivers, and several small tributaries also add more water into the system. These inter-connected rivers system makes the management and exploitation of water resources in this basin suffer from many complicated issues.

Water resources in the basin is well assessed, but the uneven seasonal distribution of rainfall, and short and

steep rivers and streams lead to many damages caused by rain and flood to people and assets.

The long dry season starts from January to August every year; because of low rainfall amounts, the dry flow only account for 30% of the total annual flow, so drought and saline intrusion in the coastal area have occurred frequently.

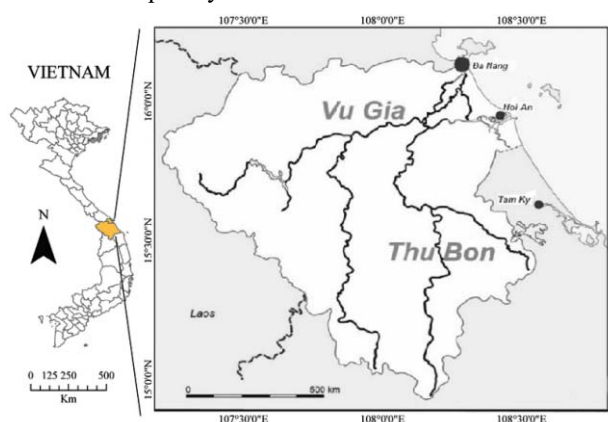


Fig. 1 Vu Gia - Thu Bon river basin

¹ Thuyloi University, 175 Tay Son Street, Dong Da District, Hanoi City, VIETNAM

² Central Region College of Technology - Economics and Water Resources, 14 Nguyen Tat Thanh Street, Hoi An City, Quang Nam province, VIETNAM

³ Center for Environmental Fluid Dynamics, VNU University of Science, 334 Nguyen Trai Street, Thanh Xuan District, Ha Noi, VIETNAM

⁴ Vietnamese-German University, Le Lai Street, Thu Dau Mot City, Binh Duong province, VIETNAM

⁵ Singapore University of Technology and Design, 8 Somapah Road Singapore 487372, SINGAPORE

The transfer of water from the Vu Gia river to the Thu Bon river, since the Dak Mi 4 hydropower reservoir was operated in 2012, also greatly affected on the supply of domestic water for the downstream area of the Vu Gia River, especially Da Nang City.

In recent years, due to the impacts of climate change and socio-economic development, the occurrence of floods in the basin has changed abnormally, and saline intrusion takes place more frequently and increasingly (CARE Vietnam, 2017). Every year, at the beginning of the dry season, the Quang Nam Irrigation Management Company has to build temporary dams to prevent saline intrusion on the Vinh Dien River to secure irrigation water for approximately 1,700 ha of agricultural lands of some communes in Dien Ban district and a part of Da Nang city. At the intake gate of the Cau Do water plant in Da Nang city at the downstream of the Vu Gia river, there was a time when salinity was up to 13,568 mg/l (July 28, 2015) which is 60 times higher than the standard level of the country. This problem affects seriously the plant in supplying domestic water for Da Nang City. In 2019, saline intrusion took place early, from the beginning of February, at the intake gate of the Cau Do Water Plant. Salinity increased gradually and remained at a high level of 1,433 mg/l (at 8:00 pm on February 15, 2019). After February 15, salinity concentration often exceeds 1,000 mg/l. Most recently, 1,585 ha of rice and crops were affected by drought and saline intrusion in the downstream of the river basin during the dry season of 2018. (Source: *Water supply joint stock company of Da Nang city*)

These statistics show that climate change already affects the security of water resources in this basin. In the past, scientists and management agencies have conducted many studies and proposed solutions to minimize the negative impacts of climate change. For example, Lan and Son (2013) studied on changes in natural disasters (floods and droughts) in Quang Nam province in the context of climate change; Phong et al. (2013) studied saline intrusion on the Vu Gia - Thu Bon river system considering climate change; Son et al. (2018) studied salinity intrusion in the downstream area of the Vu Gia - Thu Bon river system. Recent studies have contributed to provide a more comprehensive view of the hydrological regimes in the Vu Gia - Thu Bon river basin. They also provide a long-term, reliable data, creating a premise for related prospective studies in the basin. However, these studies did not assess the impacts of climate change on the trend of flow changes and the future status of saline intrusion associated with climate change scenarios, especially since the scenarios were updated in the year 2016. Based on the above analysis, in this study, we aim to assess the impact of climate change on the trend of flow and saline intrusion changes in the study basin. The result from this study may support

management agencies to promptly propose appropriate strategies for development and adapting solutions to minimizing negative impacts of climate change in the near future, ensuring sustainable development goals.

II. METHODOLOGY AND DATA

2.1. Methodology

In this study, we used an integrated approach, including the inheritance of prior research results, relevant scientific documents, field surveys and the use of mathematical models to simulate saline intrusion and flow changes, considering the impact of climate change.

2.2. Data

Hydro-meteorological data were collected from 20 gauging stations, and these data were synchronously calculated for the period from 1980 to 2016. Rainfall data were from three stations (Da Nang, Tra My and Tam Ky). Hydrological data include water level data at nine stations and two discharge stations (Nong Son and Thanh My). River cross sections and topography were updated with data measured on March 2017 (Son 2018a). Sea level data at the lower border are taken from the Son Tra and Cua Dai stations (The 2018).

Table 1. Hydrological data

No	Station	River	L*	Period
1	Nguyen Van Troi Bridge	Han	4.5	2005 - 2016
2	Cam Le	Tuy Loan	11	2005 - 2016
3	Co Man	Vinh Dien	12.5	2000 - 2016
4	Cau Lau	Thu Bon	14	2003 - 2016
5	Cam Ha	Thu Bon	10	2000 - 2016
6	Nam Ngan	Thu Bon	8	2011 - 2016

L*: Distance to the river mouth (km)

Source: Ministry of natural resources and environment

Table 2. Salinity data

No	Station	River	Period
1	Cau Do WSP ⁽¹⁾	Cau Do	2000 - 2017
2	Tu Cau ⁽²⁾	Vinh Dien	2005 - 2017
3	Cam Sa ⁽²⁾	Vinh Dien	2005 - 2017
4	Vinh Dien ⁽²⁾	Vinh Dien	2005 - 2017
5	Thanh Quyt ⁽²⁾	Vinh Dien	2005 - 2017
6	Xuyen Dong ⁽²⁾	Ben Gia	2005 - 2017
7	Ai Nghia ⁽²⁾	Yen	2005 - 2017

(1) Water supply joint stock company Da Nang;

(2) The Quang Nam Irrigation Management Company