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UNDERSTANDING THE STATUS AND CHALLENGES OF MANGROVE CONSERVATION IN CENTRAL VIETNAM: A CASE STUDY IN DUY XUYEN DISTRICT, QUANG NAM PROVINCE

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Abstract: While mangrove forests support large surrounding populations and diverse economic activities, the mangrove areas in Central Vietnam are decreasing. This study, therefore, aims to understand the current status and threats encountered with mangrove conservation and development. A survey of 52 respondents was conducted in Duy Xuyen district, the largest area of mangrove forests of Quang Nam province. The results show that 17 mangrove species belong to 11 families, in which 8 significant species and 9 minor species were found in this site. The distribution of species is uneven with Nipah palms (*Nypafruticans Wurmb*) dominating the area. Although the mangrove species have several useful functions, such as protection against wind and wave break and tourism development, mangrove areas have been decreasing from 26.39 ha to 18.22 ha from 1999 to 2018. 67.3% of respondents claim that the conversion of mangroves to aquaculture is one of the main causes of mangrove loss. The study also provides some suggestions concerning a long-term development strategy for both the government and the local community, especially those directly dependent on the mangrove for their livelihoods.

Keywords: Central Vietnam, development strategy, mangrove forest, livelihood

1 Introduction

Worldwide, mangrove forests covering an estimated area of 152,308 km^2 [1] are defined as a group of shrubs and small trees that mainly occur in the intertidal zone between land and sea along sheltered and shallow-water coastlines [2]. Mangroves, dominated by 60 species of mangrove trees, are intertidal tropical and sub-tropical coastal wetlands [2]. Tropical mangrove forest ecosystems play an important role in coastal areas, not only in the ecological services but also in the economic life of the region through activities such as aquaculture and fishing [2, 4–6]. Despite providing vital ecosystem services, mangroves are threatened worldwide. This critical ecosystem has suffered a global loss of 35% area since the 1980s [7], and 1% of the existing worldwide mangrove area is lost each year [1]. The rate is as high as 1.52% in Asia [1]. In all the Asia-Pacific countries, the mangrove ecosystems have been subjected to various forms of natural and human-made threats [8].

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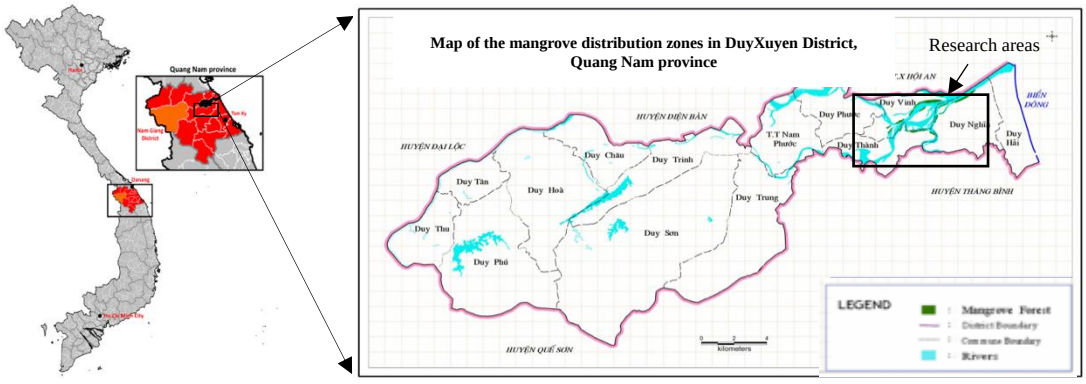
Vietnam's 3200 km long coastlines have the potential to support a substantial area of mangroves with 85,000 ha in 2014, more than 70% of which is classified as protection forests [9, 22]. In particular, the Mekong Delta is home to more than 60% of Vietnam's mangroves, with an additional 20% found in the southeast region, and almost 20% in the coastal north and central [24]. Unfortunately, Vietnam's mangroves have decreased substantially [9, 10]. The total mangrove area declined from 400,000 ha to 152,000 ha from 1945 to 1995 [11]. In 2014, the mangrove forest area reduced to 85,000 ha with much lower biodiversity and biomass and made up a very small percentage of what was natural forest [12, 21]. Loss due to herbicide attacks during the Vietnam War, overexploitation, conversion into aquaculture and typhoons [3], encouraged by land management policies are being partially counteracted by natural regeneration and replanting, especially a gradual increase in plantations as part of integrated mangrove-shrimp farming systems [9, 10, 13, 14]. Moreover, natural disasters such as hurricanes, floods, and sea-level rise have also contributed to mangrove deforestation [15, 16, 23]. Last but not least, today, climate change introduces new dimensions to the issue of mangrove loss in Vietnam [9]. The socio-economic impacts of the effects of climate change on mangrove ecosystems may include increasing risk of flooding, increasing erosion of coastlines, saline intrusion, and increased storm surges [17].

In the strategy for economic development towards sustainable development, the mangrove ecosystem and other wetlands play an important role in the economic development of coastal localities [18]. However, it has received much less publicity [7]. Thus, understanding geographical conditions and economic development context is essential for the restoration of any ecosystems [19]. As a developing country with agriculture and resources-based economy, Vietnam faces the challenge to parallel the preservation of natural landscapes and sustained economic growth and prosperity. Unfortunately, conflicts between conservation and economic development, including local livelihoods and development strategies in coastal areas, have not been satisfactorily resolved, leading to challenges in the mangrove forest conservation, especially in the context of current climate change. Therefore, practical research that is necessary for the context indicated above can generate more useful lessons for policymakers, scientists, and local government, even local communities. This leads to the initiation of this research, which has been formed and carried out to provide an overview of the current status of the mangrove forests in Duy Xuyen district, Quang Nam province to understand what threats the mangrove conservation efforts are facing, thereby providing some suggestions for sustainable development at the community level.

2 Methodology

2.1 Study site

This research was conducted in Duy Xuyen district, Quang Nam province – a meeting point of rivers before pouring into the South China Sea (known in Vietnam as the East Sea) (Figure 1). The district is also affected by the tropical monsoon climate because of its location along the central coast [20]. This locality, therefore, is known as the largest area of mangrove forests of Quang Nam province [25]. Out of 13 communes and 1 town in the district, the mangroves are distributed only in 3 riverine communes, namely Duy Thanh, Duy Nghia, and Duy Vinh. Thus, these communes are selected for the study because of their largest wetland areas, broad distribution, and unique mangrove ecosystems such as Nipah palms (*Nypafruticans Wurmb*). With such geographical features, the communes decide that the recovery and development of mangrove forests are a priority strategy in the context of climate change adaptation.



Source: [20]

Figure 1. Location map of case study in Duy Xuyen District, Quang Nam province

2.2 Data collection and analysis

Secondary data were collected from reports such as the annual land inventory of the three communes and Duy Xuyen district; the land use planning up to 2020; data on changes in forest resources and mangroves in the communes from 1997 to 2015, the communes' and district's statistical yearbooks.

Primary data: Both qualitative and quantitative methods were used in this study, namely semi-structured interviews, open in-depth interviews, and participant observations. Specifically, a survey was conducted using semi-structured questionnaires and the keynotes method with 52 local respondents. Households were randomly selected for the questionnaire survey and generally interviewed in their homes. Respondent households were randomly selected by enumerators visiting every third household as they moved through the area. When

respondents were not at home, the enumerator moved on to the next house. The interviews were carried out in August and September 2016. The questionnaire was divided into three parts, with both open and closed questions. The first section captured the socio-demographic characteristics of households. The second section used questions related to the current status of mangroves, such as total area, distribution, and species. The final section also used a mixture of open and closed questions to indicate what socio-economic factors affect mangrove forests, focusing on livelihood, tourism initiatives, and relative policies. At the same time, open in-depth interviews were organized to cross-check information with local officers at the commune and district levels. Totally, six key-informants participated in the interview, namely three chairmen of the three communes, one chairman and one vice chairman of Duy Xuyen district, and the head of the department of agriculture and rural development. In addition, participant observation and consultation of scientists, experienced managers of fisheries, agriculture, and the tourism sectors were conducted for proposals and recommendations on sustainable development of wetlands.

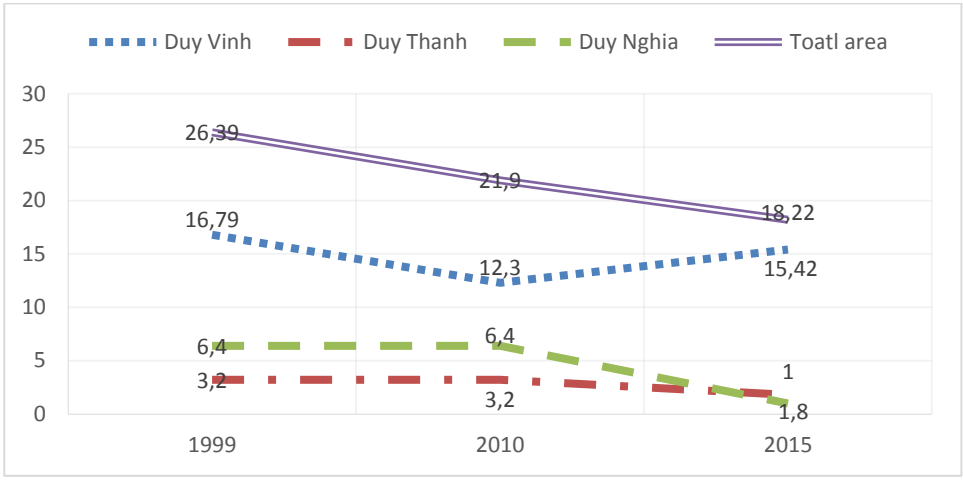
The data analysis was implemented using simple statistics in Excel software, combined with qualitative analysis to address research results.

3 Results

3.1 Overview of mangrove forests in Duy Xuyen district, Quang Nam province

Changing in mangroves from 1999 to 2015

As noted in the introduction, the district is known as the largest area of mangrove forests of Quang Nam province. According to statistic reports of Duy Xuyen district [26], the total area of mangroves was 18.22 ha in 2015, making up 0.06% of the total natural land area, distributed mainly in Duy Vinh (84.63%), Duy Thanh (9.87%), and Duy Nghia (5.5%). Compared with 1999 (26.39 ha), the year 2015 witnessed a decrease of 7.17 ha (Figure 1): 5.4 ha in Duy Nghia, 1.4 ha in Duy Thanh, and 1.37 ha in Duy Vinh. The open in-depth interviews revealed that, on the one hand, the conversion of mangroves to road construction, shrimp ponds, and houses caused losses of mangrove habitats. Especially in 2007, a large area of mangroves was destroyed by converting to shrimp ponds. As a result, the number of shrimp ponds sharply increased day by day because of high economic benefits. On the other hand, erosion is also one of the reasons leading to mangrove decrease, especially in the context of current climate change.



Source: [25, 26]

Figure 2. Changes of the mangrove forest areas in Duy Xuyen district for the period 1999–2015 (Unit: ha)

Species distribution

The results provide that most of the species were found in the estuarine and riverine areas with 17 mangrove species belonging to 11 families: 8 major species and 9 minor species (Table 1). According to Hong and San, Vietnam has 106 mangrove species belonging to 47 families with 35 major species and 71 minor species [23]. Thus, it is clear that mangrove species in this case study makes up only 16.03% of the total number of Vietnam's mangrove species, with 22.85% of major species and 12.67% of minor species. Compared with the whole country, the mangrove flora in the study site is not diverse, which is also characteristic of the mangrove regions in South-Central Coast Vietnam. Regarding the percentage of derived dominant species, this is an important factor in the structure of a stand. It denotes the proportion of each species or group of trees in the stand, and the different composition will lead to differences in other characteristics of the stand. Therefore, studying the stand structure is the first important work in the study of forest structure. The data show that the distribution of species is uneven with the domination of Nipah palms (*Nypafruticans Wurmb*) because of their good adaptation.

Table 1. List of mangrove flora in Duy Xuyen district

No.	Flora	Species	Alias*
The major mangrove species			
1	ACANTHACEAE	Acanthus ebracteatus Vahl	Sh
		Acanthus ilicifolius L.	Sh
2	ARECACEAE	Nypa fruticans Wurmb	W
3	EUPHORBIACEAE	Excoecaria agallocha L.	W
4	PTERIDACEAE	Acrostichum aureum L.	Gr
5	RHIZOPHORACEAE	Rhizophora apiculata Bl.	W
		Bruguiera gymnorrhiza Lam.	W
6	STERCULIACEAE	Sterculiaceae Vent.	W
The minor mangrove species			
7	APOCYNACE AE	Cerbera odollam Gaertn	W
8	CONVOLVULACEAE	Ipomoea pes-caprae (L.)	BW
9	CYPERACEAE	Cyperus malaccensis Lam.	Gr
		Cyperus stoloniterus Vahl.	Gr
		Cyperus tagetiformis Roxb.	Gr
10	LEGUMINOSAE	Canavalia cathartica Du Petit. Thouars	BW
		Derris trifoliata Lour.	BW
11	POACEAE	Phragmites vallatoria (L.)	Gr
		Sporobolus virginicus (L.) Kunth	Gr

*Note: W: woody plant; Sh: shrub; Gr: grass plant; BW: birthwort

Source: [26, household surveys, 2016]

The results of key interviews indicate that both major and minor mangrove species in the case study have many useful functions, such as protection against wind, wave break, soil retention, firewood extraction, household appliances, medicine, food, and serving tourism development (Table 2). The results are consistent with what Bao reported, claiming that coastal mangrove forests can mitigate high waves, even tsunamis [14]. Another review by Nehru concluded that tsunami wave flow pressure was significantly reduced when the mangrove forest was 100 m wide. The wave energy spectrum and wave power that are dissipated within a mangrove forest even over a small distance depend strongly on the mangrove structures (e.g., density, stem and root diameter, and shore slope) and the spectral characteristics of incident waves [19].

Table 2. The functions of some mangrove species in Duy Xuyen district

No.	Functions	Number of mangrove species	Percentage (%)
1	Medicine materials	3 species including – *Acrostichumaureum L.;* – *Thespesia populnea (L) Soland* – *Nypafruticans Wurmb.*	37.5
2	Timber/firewood	2 species including – *Rhizophora apiculata BL;* – *Thespesia populnea (L) Soland.*	25
3	Food	2 species including – *Acrostichumaureum L.;* – *Nypafruticans Wurmb.*	25
4	Crafts	4 species including – *CyperustagetiformisRoxb;* – *Nypafruticans Wurmb;* – *Acrostichumaureum L.;* – *Phragmites vallatoria (L.).*	50
5	House materials/tourism	2 species including – *Nypafruticans Wurmb;* – *Thespesia populnea (L) Soland.*	25
6	Ability to prevent wave, wind, and erosion	4 species including – *Nypafruticans Wurmb;* – *Rhizophora apiculata BL;* – *Acrostichumaureum L.;* – *Thespesia populnea (L) Soland.*	50

Source: [26], [household surveys, 2016]

Linkage among local livelihoods and mangrove forests

The surveys show that local livelihoods are quite diverse, with more than 7 activities (Table 3). Many types of both non-agricultural and agricultural industries exist in the area. It is obvious that mangroves play a significant role in the livelihoods of local communities. 11.5% of households directly use this resource for aquaculture; 25% are involved in capture fisheries; 9.6% go offshore fishing. Moreover, the mangrove ecosystem along rivers is considered a barrier to tropical storms that often hit the Central regions.

Table 3. Livelihood activities in the study area

No.	Livelihood activities	Respondents (n = 52)	Percentage (%)
1	Agricuture	24	46.2
2	Business	2	3.8
3	Government officials	1	1.9
4	Retire	5	9.6
5	Aquaculture	6	11.5
6	Riverine Fishery	13	25
7	Deep-Sea Fishing	5	9.6
8	Others	4	7.7

Source: [household surveys, 2016]

At the same time, most of the households agree on the importance of mangrove forests for their environment in terms of preventing saline intrusion for the paddy fields and storms (Table 4). More specifically, 15.4% of the respondents agree that mangroves have a significant ability to prevent natural disasters such as tropical storms and floods. Concurrently, 28 out of 52 respondents think that mangroves are less likely to limit the negative impacts of natural disasters. For example, the Nypa palm forests were used as a mooring place for boats and fish-ships. Such forests can mitigate high waves and reduce flow-water pressure, so-called "palm buffers"; therefore, the damages caused by the storms are insignificant.

Table 4. Community's opinions on the role of mangroves in limiting the impacts of natural disasters

Roles of mangroves in preventing natural disasters	Respondents (n = 52)	Percentage (%)
Not important	16	30.8
Important	28	53.8
Very important	8	15.4

Source: [household surveys, 2016]

3.2 Effects of socio-economic factors on mangrove ecosystems in the case study

Effect of local livelihoods on mangrove ecosystems

– Mangrove-based livelihoods

According to the results of the household interviews, it is clear that mangroves play a very important role in local people's livelihoods. Specifically, the use of mangroves in Viet Nam has a very long tradition and a wide range of utilizations. They are the production of charcoal (specifically produced from *Rhizophora apiculata* and *Bruguieraparvi flora*), fuelwood, honey, traditional medicines, and the use of wood as timber and thatching materials. According to the

results of the in-depth interviews, several years ago, local people exploited Nypa palm leaves to build houses and for selling. At that time, together with agriculture, exploitation of firewood and palm leaves in the mangrove areas became a major income of the households that rely on mangroves for their livelihoods.

However, the consequence of multi-purpose exploitation has caused serious degradation of the mangrove ecosystems. Table 5 shows the main reasons for mangrove loss. Specifically, 71.2% argued that the over-exploitation of mangrove plants is the main cause of mangrove deforestation. Although such exploitation of firewood and palm leaves in the mangrove areas does not decrease the area of mangroves directly, the palm trees cannot photosynthesize without canopy and die after a certain time. This indirectly reduces the mangrove areas. The other reasons are conversion to aquaculture and erosion with 67.3% and 63.5% of the responses, respectively. Moreover, low human capitals, including low awareness of local people and loose policies, are also serious problems in mangrove management. In addition, very few households think that climate change has an impact on the reduction of mangrove forests.

Table 5. Main reasons for mangrove degradation in Duy Xuyen

No.	Main reasons	Respondents (n = 52)	Percentage (%)
1	Over-exploitation of aqua-species	13	25.0
2	Conversion to aquaculture	35	67.3
3	Over-exploitation of mangrove plants	37	71.2
4	Erosion	33	63.5
5	Cattle grazing	12	23.1
6	Low human capital	28	53.8
7	Climate change	06	11.5

Source: [household surveys, 2016]

– Conversion of mangroves to agriculture and aquaculture

In recent years, aquaculture has turned shrimp farming in coastal estuaries to higher-profit production. Hence, shrimp farming developed rapidly without control, even over-exploiting natural resources. However, most low-density mangroves in the areas were converted from paddy rice fields that were one crop with low productivity to shrimp farming. This happened in the early 1990s, especially after the decision of the Vietnam's Government in 1999 on the changes in the structure of major land-use patterns in wetland and lowland areas. The conversion of this land to shrimp farms took place rapidly [6]. As a result, the activities of deforestation and re-planting caused mangrove changes in Duy Xuyen district. In particular, 67% of respondents said that aquaculture is one of the main causes of mangrove loss. Besides, 71.2% agree that because of a lack of information about environmental conditions, shrimp

culture techniques, and financial resources required, shrimp farming failed in some areas, or shrimp ponds were effective only in a short period. This is most evident in the riverine areas of Duy Thanh and Duy Nghia communes. After a few years, the land was degraded, and farmers continued cutting down mangrove forests and making new shrimp ponds. This is also found in reports concerning mangroves in the South Central and Mekong Delta regions, where most natural mangrove forests were cut down for firewood and converted to rice paddy fields and salt fields in the previous period or converted into shrimp farms in the later period [12, 13]. Clearly, the motivation for mangrove destruction and degradation is based on the short-term exploitation for immediate economic benefit, rather than longer-term and sustainable exploitation [6]. These are major reasons for mangrove deforestation in the previous period in Quang Nam province, as well as in Vietnam.

Effect of tourism initiative on mangrove ecosystems

According to Broham, tourism, especially, ecotourism aims to strengthen institutions designed to raise the participation of the local community and support economic, social, and cultural aspects as well [21]. In a broader term, tourism appears to be a doorway to the global economy for many rural and indigenous communities [22]. With such many potentials, Duy Xuyen is not an exception. The idea for tourism here is to connect the North-South areas of Quang Nam province, including Duy Xuyen district and Cua Dai beaches, with ancient Hoi An city, known as a famous tourist destination in Vietnam. As a result, tourism in Duy Xuyen has emerged since 2010 with some activities happening in the palm forest areas, such as sightseeing, crab/bird seeing, etc. According to locals, three benefits could be found from ecotourism, namely increasing income for households who are protecting the forests, increasing income for local participation, such as local guides and street vendors, and local's awareness of mangrove protection. Unfortunately, the utilization of mangrove forest areas for tourist purposes has been creating some negative impacts on mangrove ecosystems in Duy Xuyen district. The construction of tourist areas with several restaurants and tourism sites breaks some ecosystems, while the plan of conservation and development has not been implemented. Relating to environmental pollution, according to a report by Smith, the development of tourism infrastructures such as resorts, jetties, walkways, artificial lagoons, and groins lead to loss of habitat, wildlife disturbance, reduced aqua-species growth and altered natural wadi floodways [16].

Effect of economic growth on mangrove ecosystems

In recent years, rapid industrialization of coastal areas supported by "Doi Moi", the renovation policy implemented in 1986, has taken place. However, besides positive aspects, the process of urbanization also raises many issues, such as environmental pollution, urban transport,

housing, migration, employment, and land use transforms from the cultivating land for the demands of new urban areas. As noted previously, mangroves have been lost due to overexploitation and conversion into agriculture and aquaculture. Hence, the nature of the mangrove vegetation has markedly been changed over this period. Because the area of the mangroves in Duy Xuyen district is distributed along the riverbanks, it tends to decrease due to the frequent impact of waves, collapse of the roots, and the falling of trees into rivers, thus reducing the number of mangrove trees. The erosion of the riverbank has caused a loss of a large area of mangroves, destroying the habitat of mangrove ecosystems, and affecting the growth of mangrove trees. The consequence is the reduction of the biodiversity of the mangrove forest here as well as the protective effect of the forest.

3.3 Relevant policies for mangrove development and management in the case study

In recent years, recognizing the importance of mangroves, local authorities have implemented many activities related to mangrove management as follows: (1) Signing commitments with businesses to develop tourism with mangrove environment protection; (2) Improving the livelihood of the local people through jobs that do not depend too much on mangrove forests, such as developing vocational training activities to increase income; expanding markets for traditional local trade, especially Ban Thach mat weaving; allocating mangrove forests to organizations, individuals, and households for protection. (3) Expanding the mangrove area with the support of the National Target Program to Respond to Climate Change launched by the Government of Vietnam. These are considered as the most effective measures to preserve the mangrove forests in the local area and prevent the conversion of mangroves to shrimp farming or crop cultivation. Besides, through these activities, the local people can see the role of stakeholders in mangrove management (Table 6). The local government and local people are responsible for mangrove management. 71.2% of respondents agree that the local government plays a key role in mangrove development and management. Therefore, a long-term development strategy is necessary for the government. One the one hand, it is necessary to raise awareness for government officers from the central to commune levels. Moreover, policymakers should find and study successful models in the mangrove development and management from both global and domestic establishments, thereby can apply to the local context. On the other hand, land use planning and mangrove development plan need to be clarified and made more efficient in the context of climate change that seriously affects the coastal areas of Vietnam.

Table 6. Local people's awareness of the role of stakeholders in mangrove forest management

No.	Role of stakeholders	Respondents (n = 52)	Percentage (%)
1	Local government	37	71.2
2	Enterprises involving resource exploitation	8	15.4
3	Local people/organizations	36	69.2

Source: [household surveys, 2016]

4 Conclusion

As analyzed, the mangrove area in Vietnam is dramatically decreasing in the last decades. Such a notable decrease in mangrove land cover also occurs in Duy Xuyen district due to overexploitation and development demands, such as the conversion of forests to agriculture and aquaculture, encouraged by land management policies or tourism development. Although local people recognize what is happening and who plays the key role in mangrove management, the reality is that the biodiversity of the mangrove forest in the study site and the protective effect of the forest are reducing overtime. Thus, development strategies should start from the needs, concerns, and welfare of local communities with more participation of local people in mangrove development and protection through generating mangrove-based income, especially for those directly dependent on the mangrove for livelihood.

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