

Biophysical and Socio-economic Features of the LUCCi—Project Region: The Vu Gia Thu Bon River Basin

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Introduction to the Study Region

The project area is located in Central Vietnam and comprises the entire Vu Gia Thu Bon river basin with a total area of 10,350 km² extending from 14°54'N to 16°13'N and from 107°12'E to 108°44'E. The basin borders on the Huong River Basin to the north and the East Sea (South-China Sea) to the east. It shares borders with the Mekong River Basin to the west and southwest, and with the Tra Khuc River Basin to the south. The administrative boundaries include the Vietnamese provinces Quang Nam and Da Nang as well as very small parts of Kon Tum and Quang Ngai. Although Da Nang City does not belong to the river basin, it was included in the study area due to its relevant socio-economic features (Fig. 1).

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Fig. 1 Location of LUCCI project region in South East Asia



The project area covers the entire Quang Nam Province, as well as seven inland districts of the Da Nang Municipality. Together, the 9450 km² of the Quang Nam and Da Nang areas account for 91.8 % of the total project area of 10,350 km². The remaining 850 km² or 8.2 % of the basin are part of six mountainous communes of the Dak Glei District in Kon Tum Province. Figure 2 shows the administrative structure relevant to the project region indicating the dominance of rural districts in Quang Nam province.

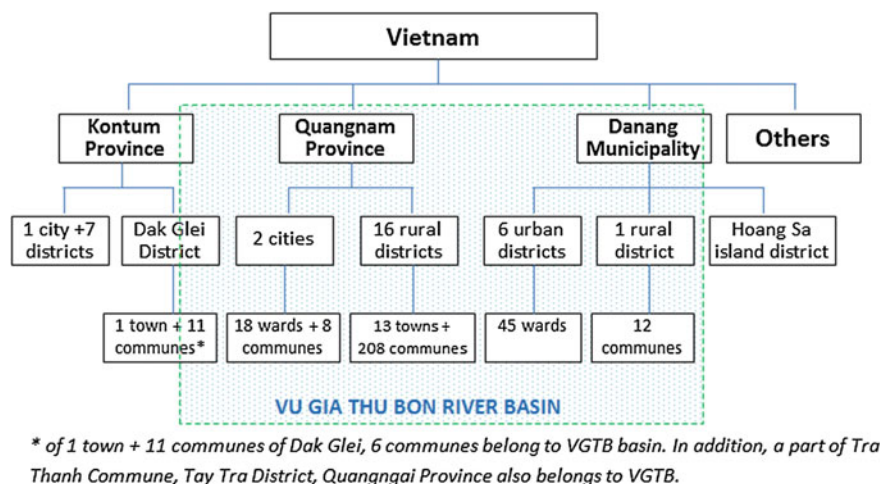


Fig. 2 Administrative organisation in the project area

Biophysical Characteristics

The Vu Gia Thu Bon (VGTB) basin is located at the eastern side of the Truong Son Mountain Range. The Thu Bon (205 km) and the Vu Gia (145 km) are the two major rivers that receive water from 19 first-order streams. Khang, Ngon Thu Bon, Ly Ly are among the major first-order streams of the Thu Bon and Giang, Bung, Con and Tuy Loan are major first-order streams of the Vu Gia. The river basin belongs to the South Central Coast Region of Vietnam within the tropical monsoon climate zone. Compared to the rest of Vietnam, this area has the longest dry season of eight months (from January to August), which is characterised by low rainfall frequently leading to droughts, and very high rainfall in wet seasons causing large-scale floods.

Topography is characterised by the Bach Ma Mountain Range in the north with peaks over 1000 m, by the South Truong Son mountains in the west with peaks over 2000 m, and by the Kon Tum mountain mass in the south, which runs out to the sea with Mount Ngoc Linh as the highest peak in the whole river basin (2598 m). The topography divides the area into three major landscapes from the west to the east. Based on the topographical features and major economic activities, the landscapes of the basin can be classified into highlands, midlands and lowlands.

According to the 2010 land use inventory of Ministry of Natural Resources and Environment (MONRE), the largest proportion of land is forested (64 %) in the highlands and midlands (compare Chapter “[Forest Change and REDD+ Strategies](#)”). The land used for cultivating annual crops makes up about 5 % of the total area and is mainly concentrated in the coastal plains as well as along the major rivers. The rural and urban settlements account for 5 % of the total area. Due to urbanisation and

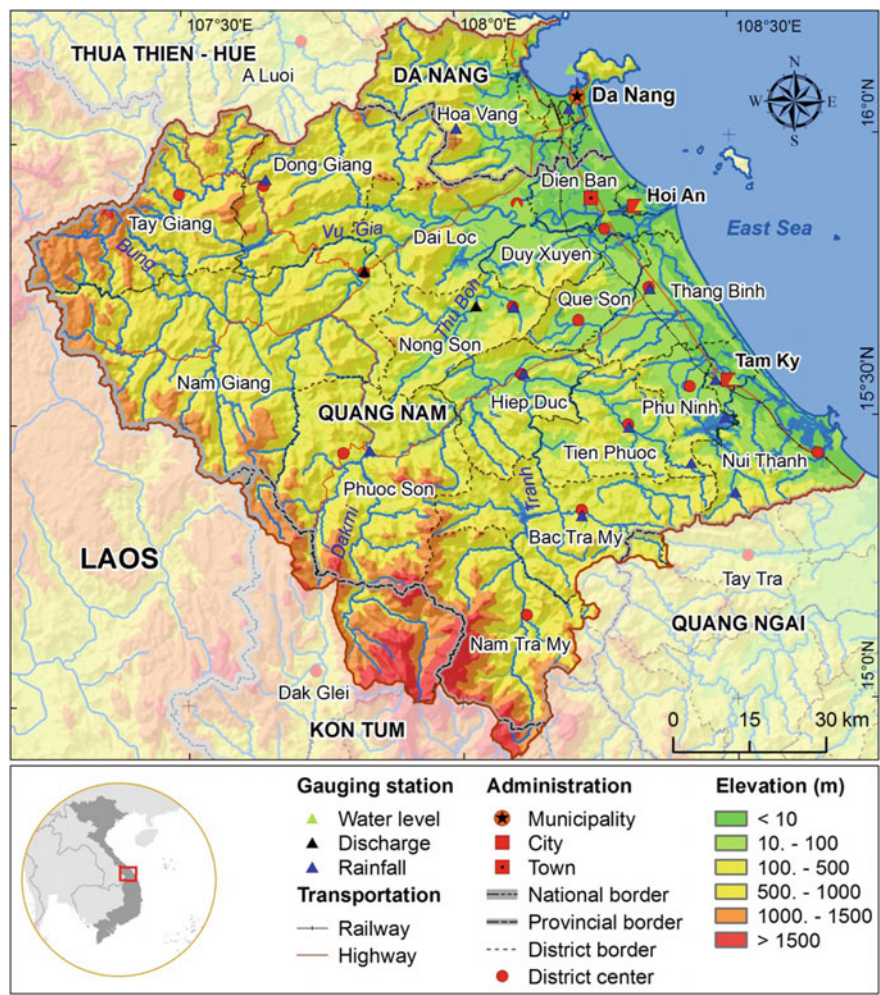


Fig. 3 Vu Gia Thu Bon River Basin

industrialisation, large parts of land along the coastal zone have been repurposed from agricultural usage to other non-agricultural usage (Fig. 3).

Major features of the basin are described in Table 1.

Climate

Due to its location below the Bach Ma hill range and the eastern direction of the West Truong Son mountain range, the climate in the VGTB river basin shows

Table 1 Features of the LUCCi project area

Location	Extended VGTB in Central Vietnam
Coordinate system	14°54'N–16°13'N; 107°12'E–108°44'E
Area	12,577 km ² (of which VGTB primary is 10,350 km ²)
Primary stream	Thu Bon (205 km) and Vu Gia (145 km)
Origin	Mount Ngoc Linh (2598 m); Mount Mang (1600 m)
Outlet	East Sea (through three mouths of Cua Han, Cua Dai and Truong Giang)
Highest point	Mount Ngoc Linh (2598 m)
Lowest point	Cua Dai Estuary (0 m)
Tributaries	Thu Bon: Tranh, Khang, Ngon Thu Bon and Ly Ly Vu Gia: Dakmi, Bung, Con and Tuy Loan
Geological features	Granite, Conglomerate, Limestone, Sandstone
Soil types	Ferrosol, Fluvisol and Acrenosol
Population	Approx. 2.5 million inhabitants
City	Da Nang, Hoi An
Land uses (2010)	Forest lands (64.0 %); paddy rice (5.0 %); and Settlement lands (4.5 %)

Source Adopted from RCHM (2013), MONRE (2002, 2009, 2014a, b, c, d, e, f) and Trinh (2014)

similar characteristics as the Southern Central Vietnamese climate with relatively warm winters, dry summers affected by dry westerly winds, and a strong rainy season with typhoons lasting from September to December.

Rainfall during the wet season accounts for 65–80 % of the total annual rainfall, with 40–50 % of the annual rainfall in October and November causing severe floods regularly (RCHM 2013).

The extended dry season lasts from January to August and is regularly accompanied by droughts, which usually occur from February to April and account for 3–5 % of the total annual rainfall. In May and June there is a second rainfall peak, which is more pronounced in the north-western part of the area.

Rainfall in the basin is unevenly spatially distributed and has a strong orographic component ranging from about 2000 mm in the flood plain to more than 4000 mm in the upper parts of Song Vu Gia, with the highest rainfall measured in Tra My. However, there are only twelve rainfall stations in the river basin, none of which are above 400 m of elevation (Fig. 4).

The annual average temperature varies between 24.5 and 25.5 °C in the mountains and between 25.5 and 26.0 °C at the coast and tends to increase gradually from North to South. Temperature data is only available for the climate stations in Da Nang and Tra My for the period 1977–2010. Maximum temperature occurs in June and July with maximum temperatures above 40 °C on days with dry westerly winds, and minimum temperatures in December and January. The lowest recorded daily temperatures at both stations have been as low as 10 °C, but the monthly mean temperatures are above 20 °C for all months. According to RCHM (2013), the following climate values were observed and calculated:

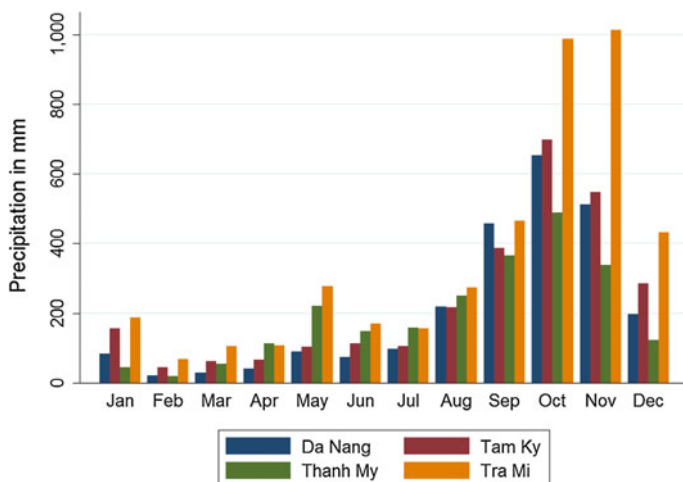


Fig. 4 Monthly precipitation at four selected stations whereas Tam Ky (South) and Da Nang (North) are located at the coast and Tra My (wetter South) and Thanh My (drier North) more inland

- The relative humidity is around 77 % in the dry season (April to September) and can reach up to 93 % in the wet season (October to March).
- The average total annual radiation ranges from about 140–150 kcal/cm². The average annual radiation balance ranges from 75 to 100 kcal/cm².
- The average annual sunshine hours vary from 1800 h in the high mountains to more than 2000 h in the coastal plain.
- The average annual wind speed is 0.7–1.3 m/s in the mountains, whereas it is 1.3–1.6 m/s in the coastal plain. The maximum observed wind speed is 34 m/s in summer, and 25 m/s in the rainy season at the Tra My station. In the coastal plain area, the wind speed reaches 40 m/s.

Hydrology

The VGTB river basin is one of the nine largest basins in Vietnam. With a drainage area of 10,350 km², the two main rivers of the basin are Vu Gia and Thu Bon, which originate in the Truong Son Mountain Range near the border to Lao P.D.R. Below the mountain range, the river and its tributary streams flow through the medium flat terrain of the coastal plain and are cross linked approximately 36 km upstream from the coast.

During the flood season, the two rivers interact through the Quang Hue and Vinh Dien rivers forming a braided river delta system. This connection is often broken in the dry season (Trinh 2014). The basin is some 100 km wide and 120 km long, and has a wide, flood-prone coastal plain backed by the steep Truong Son Mountain

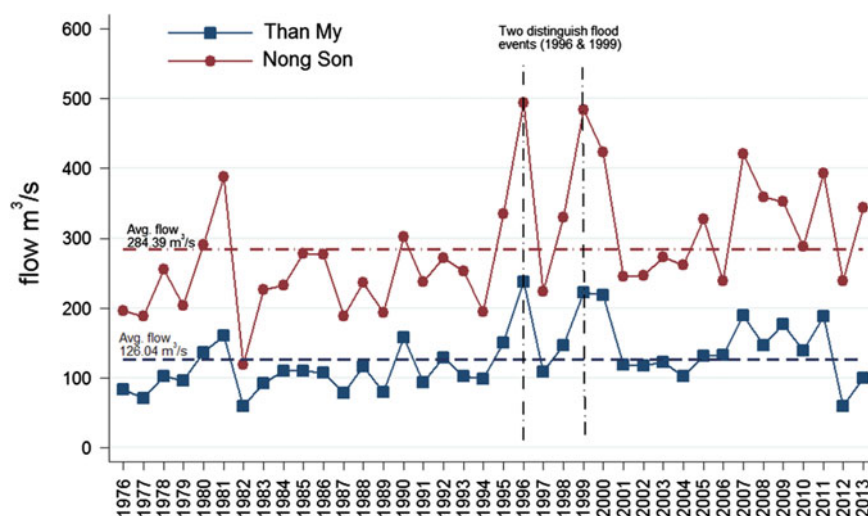


Fig. 5 Comparison of annual discharge rates at Nong Son (Thu Bon) and Thanh My (Vu Gia)

Range that rises to 2600 m. The amount of surface water flowing in the basin is directly related to precipitation, which varies geographically and seasonally. The majority of rainfall occurs in the wet season (September to December), with 70 % of runoff generated during these 3 months. In contrast, during the height of the dry season (February to March) only 12 % of runoff is generated (ICEM 2008). The basin has one of the longest dry seasons in Vietnam with 9 months of the year receiving only 30 % of the rainfall, resulting in severe water shortages and problems with saline intrusion at the coast (Trinh 2014).

Hydrological stations at Thanh My on the Vu Gia, and Nong Son on the Thu Bon have continuously gauged daily discharge since 1976. Observed data since 1976 show that the variability of river discharge is high and that the Southern Thu Bon receives much more rainfall with higher discharge. The highest flow at Nong Son was 10,600 m³/s (04-11-1999), while the lowest flow was only 4.63 m³/s (17-08-1977) (Fig. 5).

Hydro-meteorological data were collected at the Centres for Hydrology and Meteorology in each Province and IMHEN.

Socio-economical and Demographical Change

The economy of the region is rapidly changing from agriculture-based to industry and service-based, with an annual growth rate of over 10 % in the last decade. The percentage of the population working in the agricultural sector is decreasing.

In 2014, more than half of the population in the region worked in industry and service sectors, and the movement of labour forces from the agricultural sector to industry and services sectors has been increasing.

The economy of the VGTB basin is diverse, including a changing primary sector consisting of agriculture, forestry, fishery, and handicrafts, and strongly growing secondary and tertiary sectors. The basin has experienced strong economic growth in the secondary and tertiary sectors but limits to growth are projected if infrastructure development does not keep up with the pace of change. Local economies are still relatively underdeveloped compared to North and South Vietnam. A spatial distribution of economic activities in the region is apparent. Major economic centres are located in the lowlands, where dense population, high concentration of industry, services and intensive agricultural activities support dynamic growth. The economic activities in the midlands are limited to forestry, perennial crops and small-scale annual crops. Hydropower generation and forestry are two major economic activities in the midlands and uplands. Sparse population and limited access restrict economic development of the uplands. Table 2 summarises the major socio-economic features of the basin.

After separating the Quang Nam-Da Nang Province into the two provinces Quang Nam and Da Nang in 1997, the new provincial-level administrative units have been experiencing rapid economic growth since then. In the Quang Nam Province, the annual mean economic growth rate was over 8.1 % in 1997–2000, 11.9 % in 2001–2010 and 11.5 % in 2011–2014 (QSO 2005, 2014). The Da Nang municipality has also experienced high economic growth over the period from 1997 to 2014, with an annual mean growth rate of 10.3 % in 1997–2000, 11.7 % in 2001–2010 and 9.9 % in 2011–2014 (DSO 2010). High growth rates helped to narrow the development gap between the region and other economic centres in South and North Vietnam. In 2014, the GDP per capita in Quang Nam was around 1635 USD, which was approximately 79 % of the GDP per capita of Vietnam, and

Table 2 Major socio-economic features of the VGTB basin

Landscape	Area (km ²)	Population (person)	Density (per./km ²)	Land use	Economic activities
Lowlands	3370	2,024,357	600	Paddy rice, annual crop, settlement, Industrial use, special use	Processing and light industries service, tourism, intensive agriculture
Midlands	4120	364,016	88	Forest, perennial crops, annual crop, paddy rice	Hydropower generation, forest product exploitation, agriculture
Uplands	7220 5585	142,508 84,666	15	Forest, perennial crops, annual crop	Hydropower generation, forest product exploitation

Source Synthesised from QSO (2014) and DSO (2014)

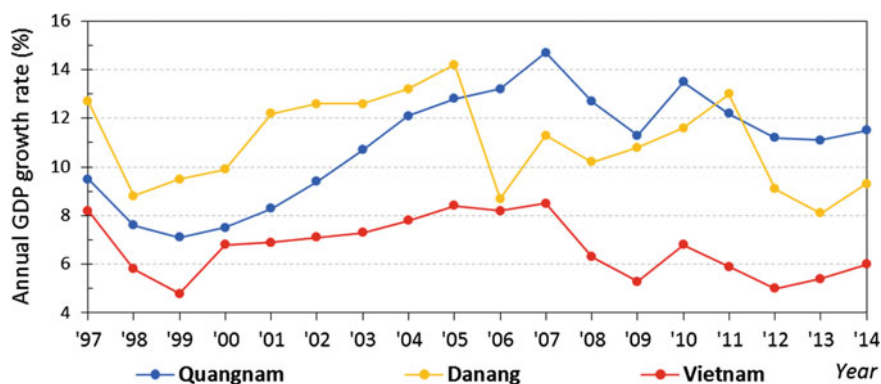


Fig. 6 Annual GDP growth rate of Quang Nam and Da Nang in comparison to Vietnam in 1997–2014 (Data GSO, QSO, DSO in 1997–2014)

in Da Nang it was around 2800 USD, which was approximately 140 % of the GDP per capita of Vietnam (QSO 2014; DSO 2014) (Fig. 6).

The enormous growth in Quang Nam Province is mainly driven by the development of the secondary (industry and construction) and tertiary (service) sectors. The development of these sectors has induced a structural change in the economy. The contribution of the agricultural sector to the GDP in Quang Nam decreased from 48 % in 1997 to 17 % in 2014, whereas the contribution of the industrial and services sectors increased from 52 % in 1997 to 83 % in 2014. Consequently, although a high proportion of the population still depends on agriculture, forestry and fishing, the number of people working in this sector decreased remarkably from 78 % in 1997 to 51 % in 2013 (QSO 2005, 2014).

In contrast to Quang Nam, the economic development of the Da Nang municipality was dominantly fuelled by the development of industry and services. The proportion of agriculture in the economy decreased from 7.9 % in 2000 to 3 % in 2011, while the share of industry and construction increased from 40.3 to 46 % and the share of services sector was relatively stable at 51 % GDP in the same period (DSO 2014).

The VGTB is home to approximately 2.5 million inhabitants (2013), 80 % of which live in the coastal lowlands, 45 % of which live in the urban areas. The mean population density in the basin was 197 persons per km² but distributed unevenly with high density in the lowlands, low in the midlands and very low in the uplands, with a density lower than 20 persons per km², except for some concentrations in small district centres. The density of population in midlands, which are transactional areas between uplands and lowlands, varies from 20 to 100 persons per km². The population is densely concentrated in the lowlands, particularly in the cities, where the density is over 5000 persons per km².

The annual mean growth rate of population during 1995–2013 was 0.58 % in the Quang Nam Province and 2.52 % in the Da Nang municipality (GSO 2014). Migration plays an important role in population growth of the region. The large flux

Table 3 Net migration rate of Quang Nam and Da Nang in 2005–2013

Year		2005	2007	2008	2009	2010	2011	2012	2013
Net migration rate (‰)	Da Nang	3.8	7.6	6.5	15.3	26.4	14.9	11.2	5.8
	Quang Nam	−4.3	−4.5	−4.3	−8.0	−9.7	−2.3	−3.6	−1.5

Data GSO (2014)

of migration caused low growth rates in the Quang Nam Province, while a high immigration rate supplied more labour force for the Da Nang municipality. The high growth rate in Da Nang was fuelled by rapid urbanisation. The low population growth in Quang Nam will pose a challenge for providing an adequate labour force for the local economy in the future.

The population of Quang Nam in 2013 was 1,449,000, growing on average by 7722 persons each year. During 1995–2014, the population of Da Nang increased to 355,500 persons, growing on average by 19,750 persons each year. The average annual growth rate of the population in Quang Nam between 2006 and 2014 was 0.5 %, a decrease compared to 0.7 % in 1995–2005 (QSO 2005). Unlike Quang Nam, the population in Da Nang increased with a higher rate in 2006–2014 (2.6 %) in comparison to 2.4 % in 1995–2005 (DSO 2010, 2014). The differences in population growth between Quang Nam and Da Nang resulted from migration (Table 3).

Quang Nam has a young population: 20.7 % of the population is under 15 years old, while only 9 % of the population is over 65 years old (GSO 2014). The urbanisation rate in Quang Nam is low with only 19.2 % of the population living in urban areas, compared to 32.2 % in Vietnam and 37.0 % in the Southern Central Coast (PPC Quang Nam) (GSO 2014). However, due to rapid industrialisation, urbanisation will speed up in the coming years. According to the Strategy for Urban Development to 2020 prepared by PPC Quang Nam in cooperation with UN Habitat, approximately 41.7 % of the population in the province will live in urban areas by 2020 (PPC Quang Nam 2014). The urban centres are concentrated in the lowlands, along the 1A National Highway.

The total population of Da Nang City in 2013 was 887,435 persons with an urbanisation rate of the city is the highest in Vietnam, with 86.9 % of the population living in urban areas in 2009 compared with 32.2 % in Vietnam (GSO 2010). For the whole VGTB River Basin, the urbanisation rate is 44.8 %, a high rate compared to other regions in Vietnam such as 29.3 % in the Red Delta, 57.2 % in the South East Region and 22.8 % in the Mekong Delta (GSO 2014). The region also has a small family size with, on average, 3.76 persons per family in Quang Nam and 3.91 persons per family in Da Nang compared to 3.82 persons per family in Vietnam.

Agricultural Sector

Paddy cultivation and livestock farming are the two main agricultural activities in the basin. Paddy cultivation is the most important agricultural activity. Two crops

of paddy are planted per year in the lowlands and areas along major rivers, where ample water resources exist for irrigation. Even in the valleys of the mountainous areas, at least one crop of paddy rice is planted per year. Paddy rice is planted intensively in the Dai Loc, Dien Ban, Duy Xuyen, Que Son, Thang Binh and Phu Ninh districts in the Quang Nam Province and the Hoa Vang District in the Da Nang Municipality. Other annual crops such as cassava, maize, sweet potato, peanut and sesame are also planted in the lowlands, particularly in the coastal areas. Pepper, rubber and cinnamon are the main perennial crops in the region and are planted in the upstream parts of the Thu Bon sub-basin.

From 1995 to 2013, planted areas of paddy in the region decreased by 21 % from 106,200 ha in 1995 to 87,900 ha in 2013. The planted area in Da Nang, in particular, decreased by 60 % from 13,400 ha (1995) to 5400 ha (2013) due to the expansion of settlement areas (GSO 2014). However, paddy production during this period increased by 30 % from 362,000 tonnes (1995) to 471,000 tonnes (2013) due to a significant increase in paddy yield (GSO 2014). The paddy yield in the region has increased by 67 % from 3.02 tonnes/ha (1995) to 5.05 tonnes/ha (2013) (QSO 2005, 2014) (Fig. 7).

According to land use planning, the paddy planting areas in the region will continuously decrease to 42,711 ha in 2020 from 43,979 ha in 2015 (MONRE 2014a, b, c, d, e and f). The reduction will mainly take place in the area surrounding Da Nang, where the urbanisation and industrialisation processes are occurring rapidly.

The typical livestock reared in the basin are buffaloes, cattle, pigs, poultry and goats. Although its contribution to the agricultural sector is not as high as crop cultivation, livestock farming is very important given the local consumption habits and culture. Like in other regions of Vietnam, animal farming is typically undertaken by small-scale farm households. The sizes of herds depend on the type of animals, ranging from 3 to 20 heads per farm household. Pig and poultry raising activities are mainly undertaken in the lowland districts such as the Dai Loc, Dien Ban, Que Son, Duy Xuyen, Thang Binh, Nui Thanh and Phu Ninh districts, where cropping is more developed. This is not surprising given the fact that many agricultural by-products are used to feed livestock, mainly pigs and poultry. Crop cultivation is essential for pig and poultry farming. Buffaloes and cattle are mainly raised on natural grass and pastures so they are more developed in districts such as Thang Binh, Phu Ninh and Nui Thanh, where this activity is more propitious.

Industrial and Construction Sector

The manufacturing sector plays an important role in the economic activities in the region. The rapid development of manufacturing in the recent years is the key factor energising the economic growth rate of the region. During the last 17 years



Fig. 7 Spatial distribution of agricultural land uses in the basin

(1997–2014) since establishing the province, the industry of Quang Nam has grown by 18.7 % per year, particularly in the last 10 years. The industry of Da Nang has also grown rapidly. The growth rate of industry is much higher than the average growth rate of service and agricultural sectors and therefore the share of industry in the GDP of the region is significantly increasing. The GDP share of industry in Quang Nam increased from 19.6 % in 1997 to 42.0 % in 2014 and it has increased from 40.3 to 46.0 % in the same period in Da Nang. The proportion of labour force in industry has also significantly increased from 4.5 % in 1997 to around 23 % in 2014 (QSO 2014).

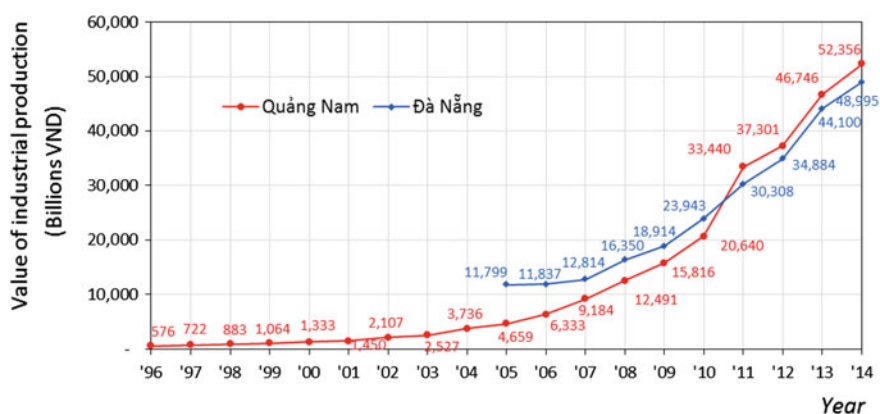


Fig. 8 Value of industrial production of Quang Nam and Da Nang in 1996–2014 (Data GSO 2014)

The industrial development in Quang Nam and Da Nang from 1996 to 2014 is plotted in Fig. 8. Industrial values in Quang Nam have increased by a factor of 90 since 1996 (QSO 2005, 2014). Da Nang is the largest industrial centre in the region. The industrial production of the city is mainly concentrated in the industrial parks located in surrounding areas such as Hoa Khanh, Extended Hoa Khanh, Hoa Cam, Tho Quang and An Don. A high-tech industrial park has also been constructed in the outskirts of the city (Fig. 9).

The Chu Lai Open Economic Zone is the largest industrial centre in the Quang Nam Province. A cluster of industrial parks, developed in the southern coastal parts of the province, drives the industrial development in the region. Dien Ban and Tam Ky are the other industrial centres in the province (Fig. 9).

The major industrial products in the region are automobile products, rubber, garments, footwear, glass, processed food, software and construction materials. Handicraft goods are also developed in the region. The Tra Kieu bronze casting handicraft village and the Ma Chau silk village are the most populous traditional handicraft villages in the region.

Industry in the region is expected to continue growing at a high rate in the future thanks to the expansion of local and foreign direct investment.

Service and Tourism Sector

The service sector accounted for 41 and 51 % GDP in Quang Nam and Da Nang in 2014, respectively (GSO 2014). In Quang Nam, the growth rate of service sector

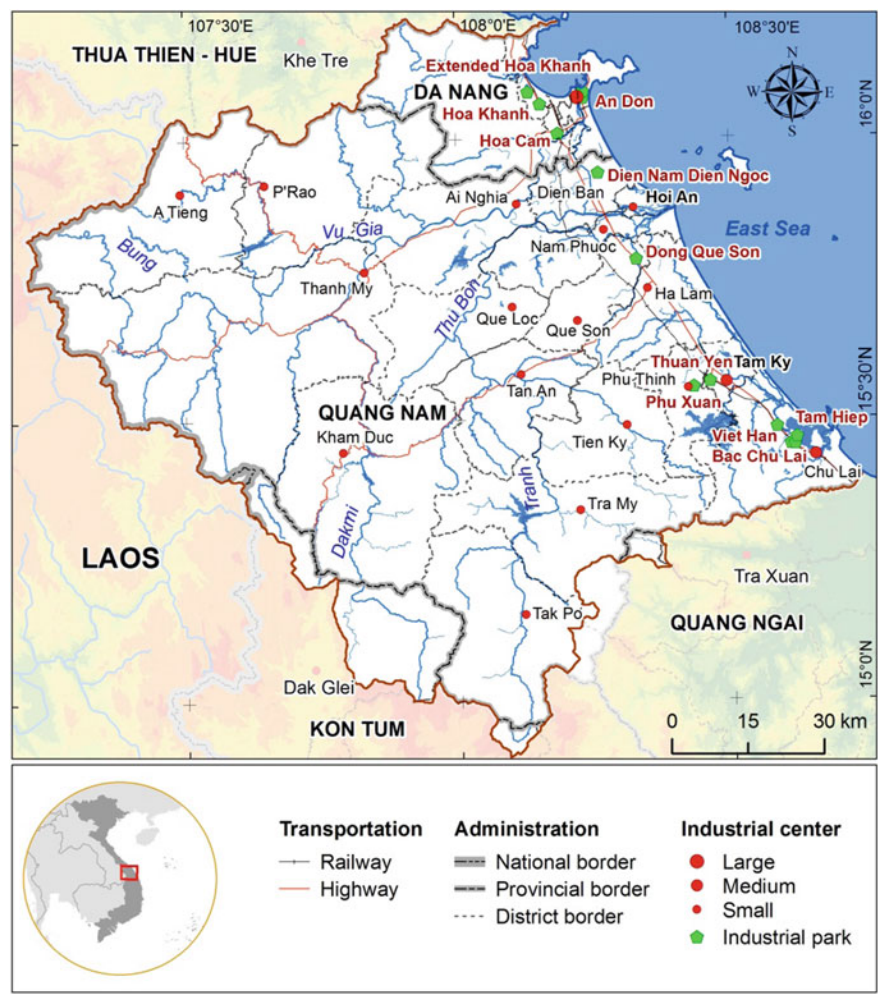


Fig. 9 Industrial centres and industrial parks in the basin

was always higher than the average growth rate of the GDP, and therefore the proportion of service increased continuously from 31 % in 1997 to 41 % in 2014 (QSO 2005, 2014). Other than in Quang Nam, due to the service-based economy, the proportion of service in Da Nang economy has remained high and has contributed to half of the GDP during the last ten years.

The region has high potential to develop tourism, particularly sea tourism. Hoi An and My Son are both world cultural heritage sites. Da Nang and Hoi An are two of the largest tourist centres in Vietnam and attract millions of visitors every year.

Typical Disasters in the Research Area

The river basin is regularly influenced by natural disasters such as typhoons, tropical depressions, flooding, droughts, salinity intrusion, landslides, riverbank and coastal erosion. Flooding occurs frequently from September to December, while droughts and salinity intrusion take place during the period from February to August. Droughts do not occur in the whole basin, but are concentrated in the Thu Bon and Tam Ky sub-catchments. Low water levels in the river during the dry seasons result in saltwater intruding further inland. Riverbank erosion is a severe problem for communities along the Vu Gia and Thu Bon rivers, while coastal erosion is a large concern for the local communities along the 200 km long coastal line. Additionally, torrential rains in the mountainous areas cause flash floods. Figure 10 illustrates the different types of disasters in the region.

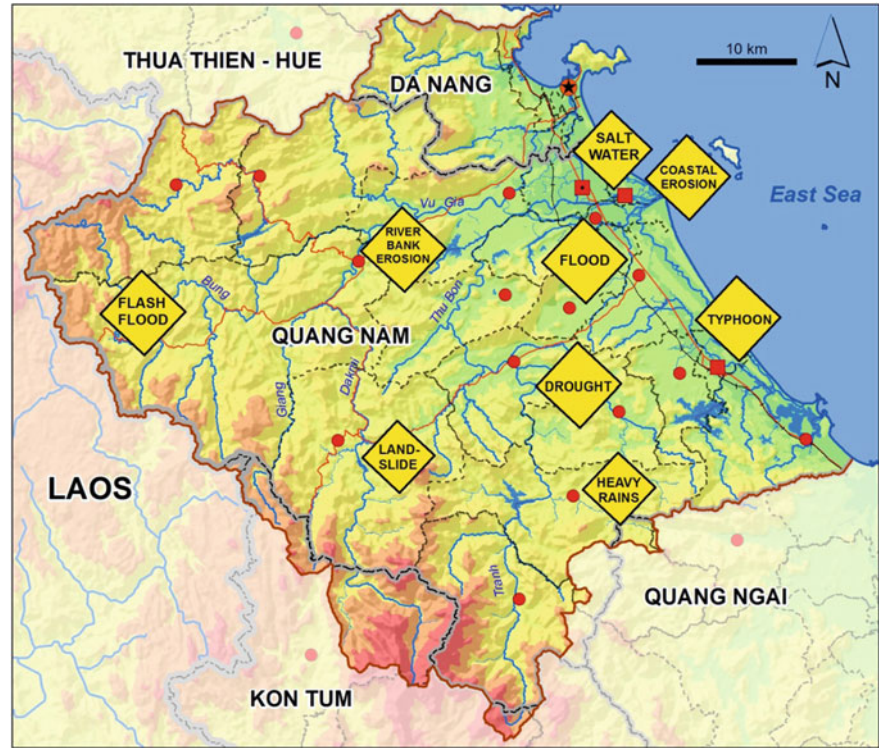


Fig. 10 Disasters in the basin

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