1 Introduction

1.1 Overview

The Mekong is one of the world's largest rivers, with a catchment area of 795,000 km^2, a mean discharge of 15,000 m^3/s, and a length of about 4,900 km (van Zalinge *et al.*, 2004). The river rises in eastern Tibet and discharges into the South China Sea. The Lower Mekong Basin (LMB) lies within Cambodia, Lao PDR, Thailand, and Viet Nam (Figures 1 – 3) and is home to about 60 million people (MRC, 2003). The lower Mekong river system with its extensive associated floodplains and wetlands supports important inland fisheries (Sverdrup-Jensen, 2002). As well as the catching or growing of fish and other aquatic animals (OAAs), fisheries involve processing, transporting and marketing of fishery products and many other supporting industries. Fisheries in the LMB occupy millions of people who work full- or part-time, as individuals or in small groups, or as part of large commercial operations. Fisheries are dispersed through many environments: rivers, floodplains and natural wetlands, as well as in agricultural landscapes, and are seasonal, with catches or harvests peaking at various times in different places. Hundreds of wild fish species are caught, as well as a wide range of other aquatic animals (OAAs), including shrimps, crabs, molluscs, insects, snakes and turtles. Aquaculture is of less importance, but dozens of species are cultured commonly (Phillips, 2002).

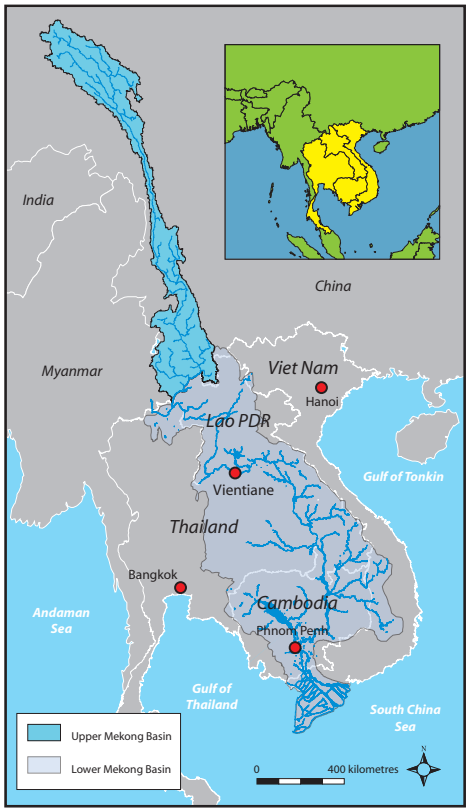

Figure 1. The Mekong Basin.

As is usual for large tropical river systems, there are no reliable basin-wide catch assessments, despite the basin's fisheries being described by the MRC as the 'linch-pin in the Basin's development' (Kristensen, 2002). Assessing the size and value of the capture fishery is difficult and complex because of the diversity of habitats and species, the seasonal variability of the yield, the dispersed geographic spread of many fisheries, and the range in scale of different types of fisheries (from solitary fishers to industrial enterprises).

The lack of accurate quantitative data on fisheries leads to relative neglect in development planning, which tends to emphasise other sectors that may compete with the fishery for use of water as populations grow and demands on the river increase. However, all sectors should be given appropriate weight in development planning, at both a basin-wide level

and when considering individual water management projects. Therefore, estimates of the yield (production) and value of fisheries are needed, so that benefits from developments in other sectors can be judged against the effects on the fishery. Various estimates of yield have been published, but as discussed below, all suffer from incomplete information or a lack of supporting evidence or analysis.

This report seeks to:

- introduce features of the importance of fisheries in the LMB, discuss basic concepts about yield and production, review published estimates of yield, and explain the basis for this review (Chapter 1);
- provide accurate estimates of the population and area of the LMB (Chapter 2);
- review terminology for fisheries products and derive conversion factors (Chapter 3);
- review studies that include consumption estimates within the LMB and extrapolate from these figures to estimate basin-wide consumption; estimate yield and the contribution from aquaculture and capture fisheries (Chapter 4);
- compare the LMB consumption and yield estimates with other data (Chapter 5);
- discuss and summarise the review and recommend directions for future work to improve yield estimates (Chapter 6).

1.2 The importance of fish and OAAs in the Lower Mekong Basin

In the LMB, fish and OAAs are eaten regularly by almost all people, providing a major source of protein and essential elements (including calcium, iron, and zinc) and vitamins—particularly vitamin A. Smaller fish generally have higher mineral content than large fish, so they are particularly important to the rural poor who tend to eat small fish and sell larger fish (Roos, 2003). People in the LMB usually eat most of the internal organs of larger fish, and small fish are often eaten whole or beheaded. Aspects of nutrition are discussed in detail by Mogensen (2001) and nutritional tables for fish and OAAs are provided by Puwastien *et al*. (1999). Fisheries contribute to livelihoods by engaging many people in direct or indirect employment and providing sustenance, so enabling people to engage in other useful employment and attain a decent standard of living. Many people in the LMB countries still depend upon local fisheries products for food security. Fisheries also link with culture and provide complementary roles for all members of the family; typically men work on gear and catch fish, whereas women sell or process the catch and fish locally for household consumption, and children assist in various ways.

1.3 Yield and production

The yield from any biological system is defined as the portion of production removed for use by humans over a given period of time. Biologists define production as the total biomass produced during a given period of time from a defined area, so production includes the biomass that is produced but not harvested by people. In national economic statistical tables (such as those compiled by the FAO) yield is usually termed production; i.e. what biologists refer to as 'yield' economists call 'production'. Yield is the term used throughout this report. The units of yield are generally kg per capita per year, or metric tonnes from a stated area per year. Yield is the best indicator of the size of the fishery, as biological production is impossible to measure in large systems. Consumption usually forms a large part of the yield in large floodplain systems such as the Mekong, where the bulk of catches are consumed locally (see also Chapter 4.6).

1.4 Estimating yield

There are four ways to estimate the yield of the LMB fishery:

- *By monitoring catches*. Larger commercial operations or catches passing through well-defined landing sites can be monitored, but the dominant small-scale subsistence or artisanal fishers are difficult to monitor directly in seasonal and geographically-dispersed fisheries. Moreover, fishers may under-report catches for various reasons, for example to avoid taxes or to avoid attracting the attention of competing fishers.

- *By monitoring trade and marketing*. In the LMB many fishery products are not marketed or traded but rather are eaten by the fishers or their families, or others who buy or barter directly with fishers, so this method neglects a large part of the yield. Licensed traders may under-report sales to avoid taxes. Illegal cross-border trade in the LMB is common but impossible to monitor.

- *By multiplying per capita consumption (i.e. food eaten) by population*. This method has the advantages that per capita consumption is within known limits (based on other studies and physical limits to each person's capacity to eat) and, as all the LMB governments conduct censuses, the error in population estimates is small. Information is also needed on imports, exports, wastage and use in animal feeds.

- *By estimating habitat area (especially flooded area), and multiplying by yield per unit area*. Studies of small well-defined areas in floodplain rivers show that fish yield depends largely upon the area and duration of seasonal flooding, as well as fishing effort. Unfortunately, there is no general relationship that could be applied basin-wide, but habitat area can be used to provide some indication of the range of yield, as is discussed in Chapter 5.3.

1.5 Previous estimates of yield

Several estimates of fish yield in the LMB have already been published.

The Netherlands Economic Institute estimated that total fish consumption in the LMB in 1970 was 492,000 tonnes/year, based on assumed per capita consumption of 16.4 kg/capita/year and a population of about 30 million (cited in Lagler 1976, p. 33). Compilation of official catch statistics from commercial operations, combined with estimates of subsistence catches (based on trial fishing and field observations), gave a range of 460–511,000 tonnes/year for LMB catches in 1973 (Lagler, 1976, p. 197), a range that encompassed the estimate based on assumed consumption.

The Mekong Basin Fishery Sector Review (Anonymous, 1992, p. 10) estimated fish consumption in the LMB was 6.5–30 kg/capita/year in 1989–90, based on assumptions about relative protein contribution from fish versus other sources. According to official production statistics the total inland fish yield at the time was 357,134 tonnes for a LMB population of 47.8 million. The official statistics were noted as 'generally unreliable' as they did not include the bulk of the catch, which is from subsistence and small-scale fishing. Moreover, official returns from licensed commercial fishers are also likely to be generally under-reported for many reasons. The review noted that a monitoring study in northeast Thailand found actual monitored consumption was 5.5 times higher than official production (Study 12 in Chapter 4, below). The total inland fish catch estimated by the Sector Review for the LMB was about 670,000 tonnes, but this total was obtained by summing the *consumption* data from northeast Thailand with official *catch* data from Cambodia, Lao PDR, and Viet Nam. If a similar under-reporting bias were to be assumed and the factor of 5.5 applied to the official catch data from the latter three countries, the total consumption estimate would be about two million tonnes for 1989–90.

Small-scale fisheries were covered in a number of surveys in the late 1980s and 1990s. Jensen (1996) quoted two of these studies (from Cambodia and northeast Thailand) and suggested that total basin production could be more than one million tonnes per year. More recently, Jensen (2000, 2001) provided some further preliminary figures from MRC-sponsored surveys in Lao PDR and Viet Nam, and he has also suggested that the capture fishery alone may be greater than one million tonnes per year, with aquaculture accounting for a further 200,000 tonnes/year.

A recent sector review (Sverdrup-Jensen, 2002) tabulated estimated consumption figures for each country based on a draft report by Sjorslev (2001). The total estimate was 2.033 million tonnes for a population of 56.259 million people in the years 1999/2000, giving a per capita estimate of 36 kg/year of fish, presumably as FWAEs.

Most recently, a summary table was presented by van Zalinge *et al*. (2004), who were then quoted by the ADB (2005) and possibly others. The summary table shows estimated total consumption in each LMB country, based on a draft report by Hortle and Bush for the year 2000. The total yield was estimated as 2.7 million tonnes/year of fish and 0.4 million tonnes/year of other aquatic animals as FWAEs. The draft report of Hortle and Bush was not

finalised, because inaccuracies were identified in the databases and new information became available. Consequently, the present report has been prepared to re-estimate the yield of the LMB and to state clearly the basis for the estimate.

In summary, published estimates for fishery production of the LMB varied between 0.5 and 3.1 million tonnes per year, between the years 1970 and 2000. Allowing for constant per capita consumption would raise the 1970s figure from 0.5 to about one million tonnes in 2000. Thus, previously published estimates, when adjusted for population, provide a range for annual yield of about 1–3 million tonnes for the year 2000, but the bases for the estimates have as yet not been documented properly.

1.6 Estimating basin-wide consumption and yield

Estimates for the consumption of the whole LMB were built from the 'bottom up', firstly on a province-by-province basis[1], and then on a country-by-country basis[2]. For those provinces where data were available, total consumption was derived by multiplying the province's population in the year 2000 by an estimate of its per capita consumption. For those provinces where per capita consumption figures were unavailable, total consumption was derived using per capita consumption data from nearby provinces that have similar ecology and comparable socio-economic structure.

Because individual consumption estimates were made in various years (1988–2002, Table 8), it was necessary to adjust the data to a common year for which population census figures were available; 2000 is the most recent of these 'common years'. It was assumed that per capita consumption was constant and that provincial consumption increased with population growth, which is about 2–2.5% in the LMB (MRC, 2003).

To estimate yield, additional information was sought on imports, exports, aquaculture production and use of trash fish in aquaculture.

1 A lower level of resolution (e.g. at district level) was not possible because of insufficient data.
2 Except in Lao PDR where results from a national-level census were used.

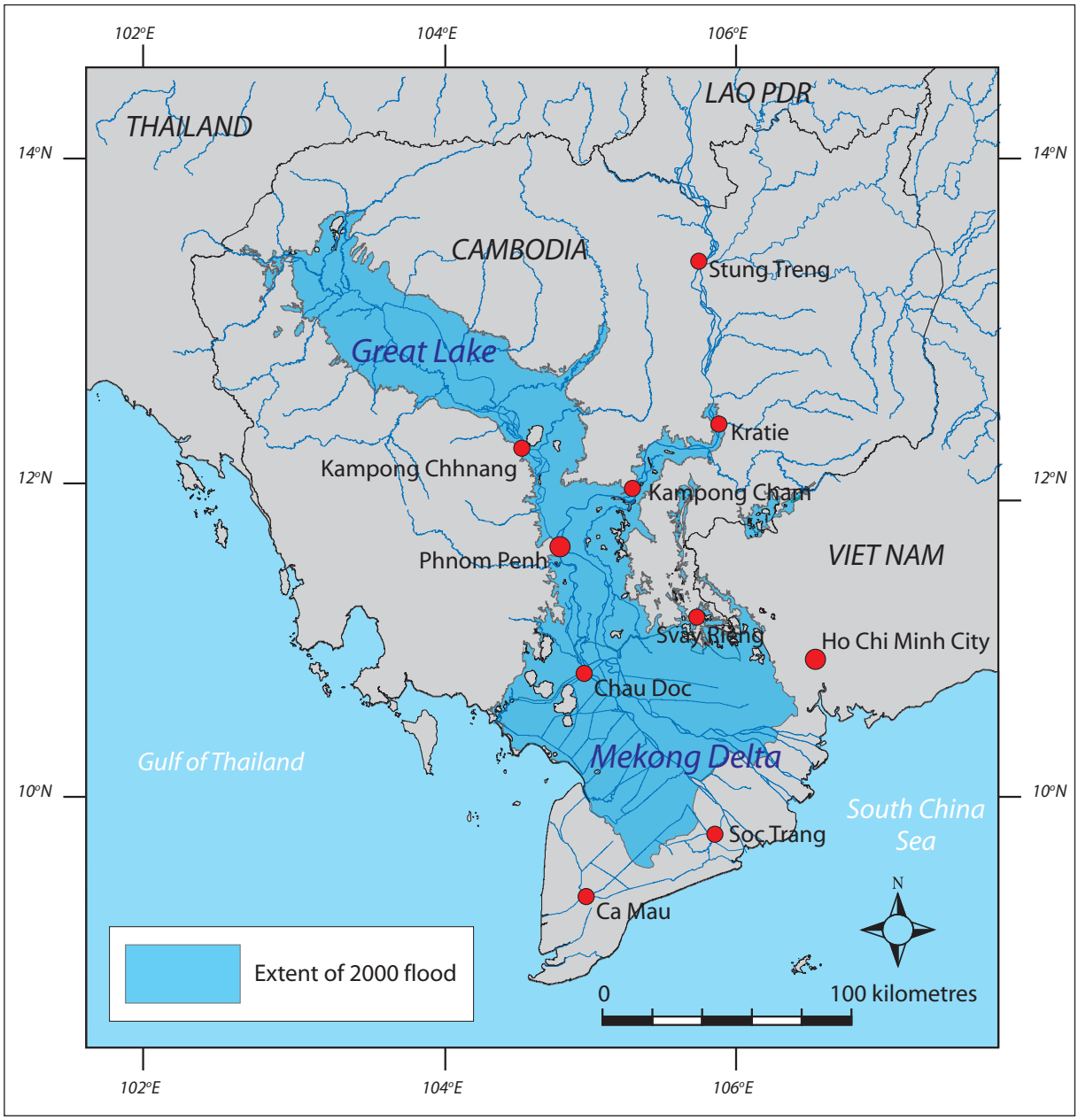

Figure 2. The extent of the flood in the year 2000 (a year with an above-average flood) in the Great Lake – Mekong Delta area.

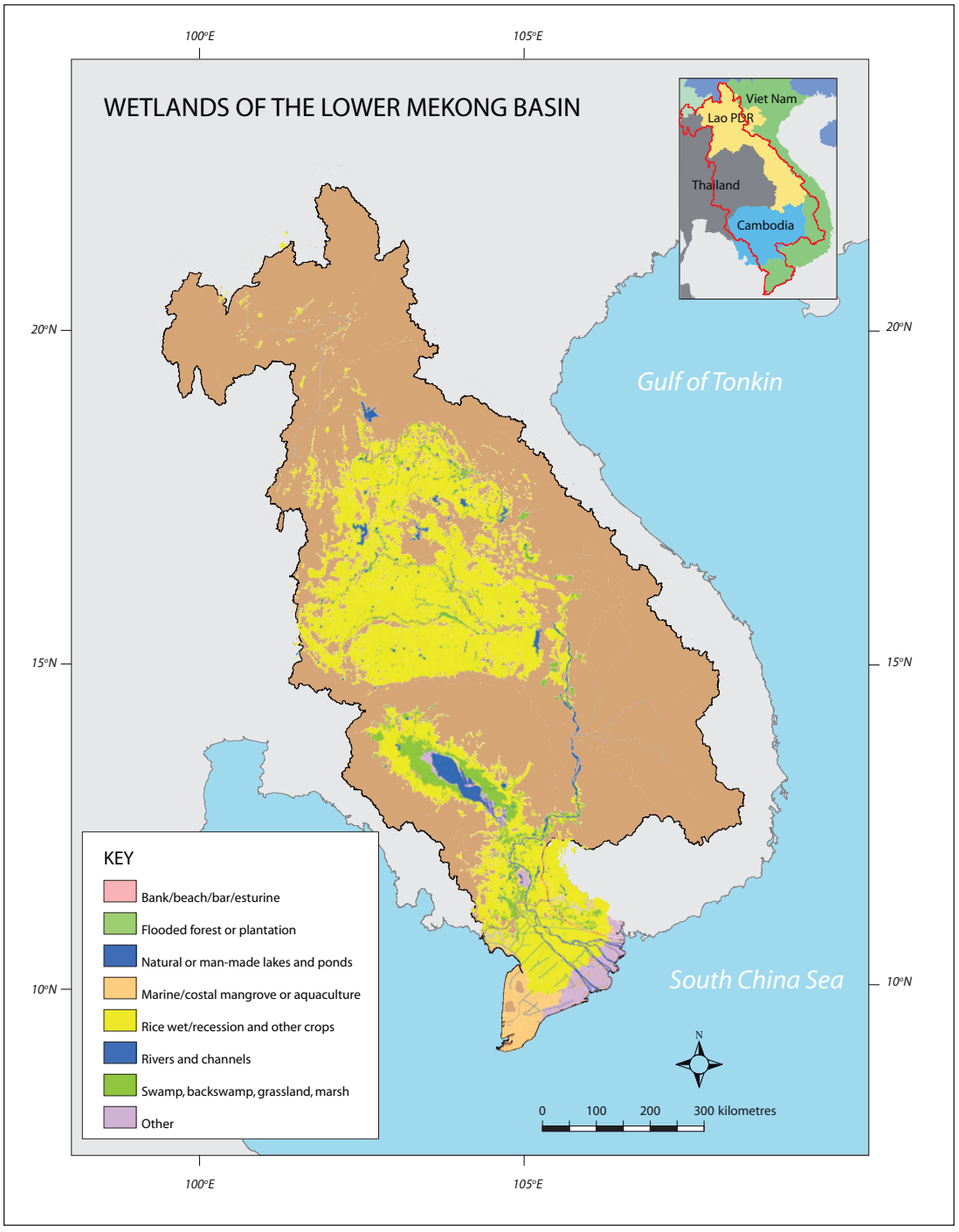

Figure 3. The extent and types of wetlands in the Lower Mekong Basin.

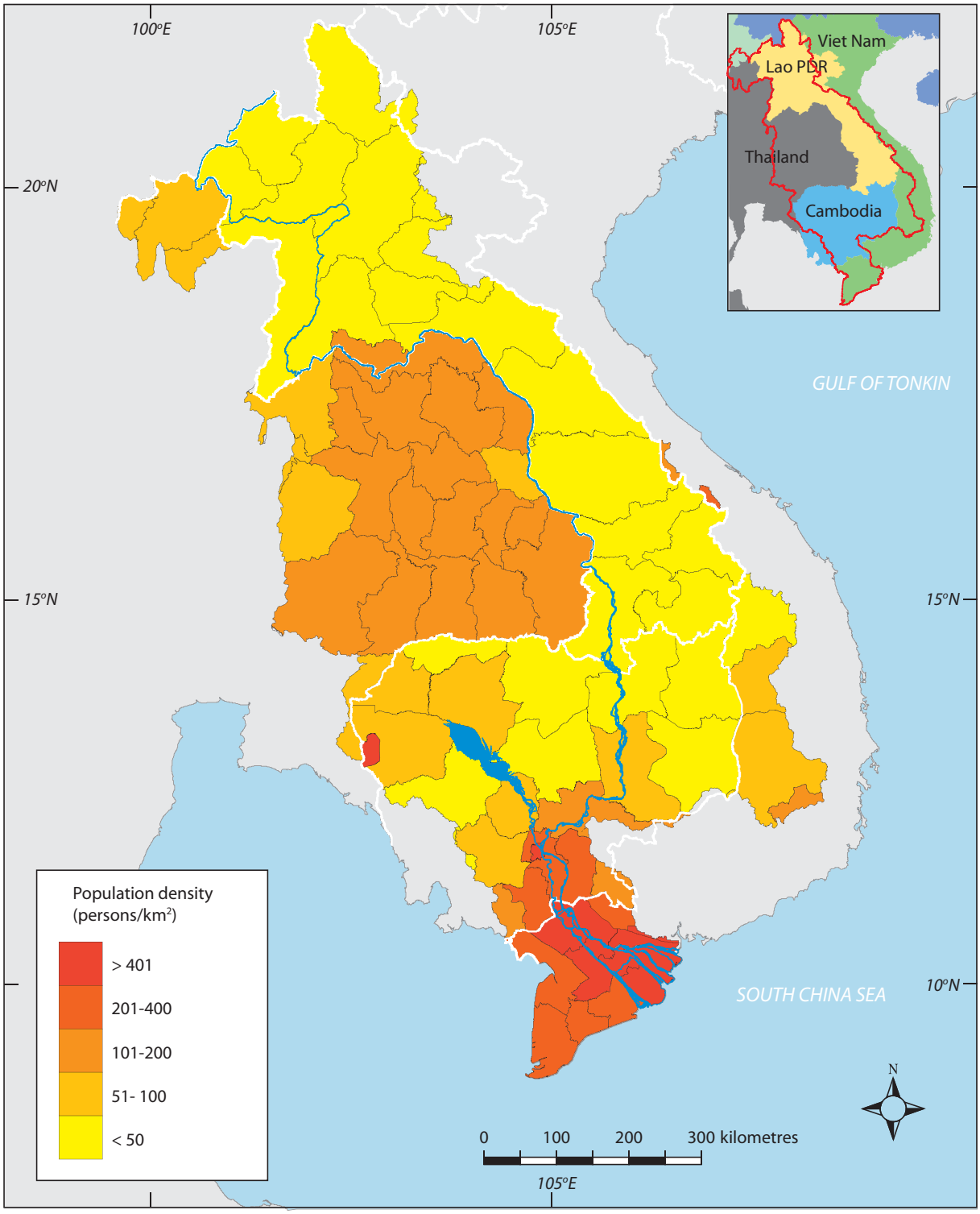

Figure 4. Distribution of population in the Lower Mekong Basin by province.
Categories are based on mean values for each province. Population density is usually higher along rivers and lower in elevated areas.