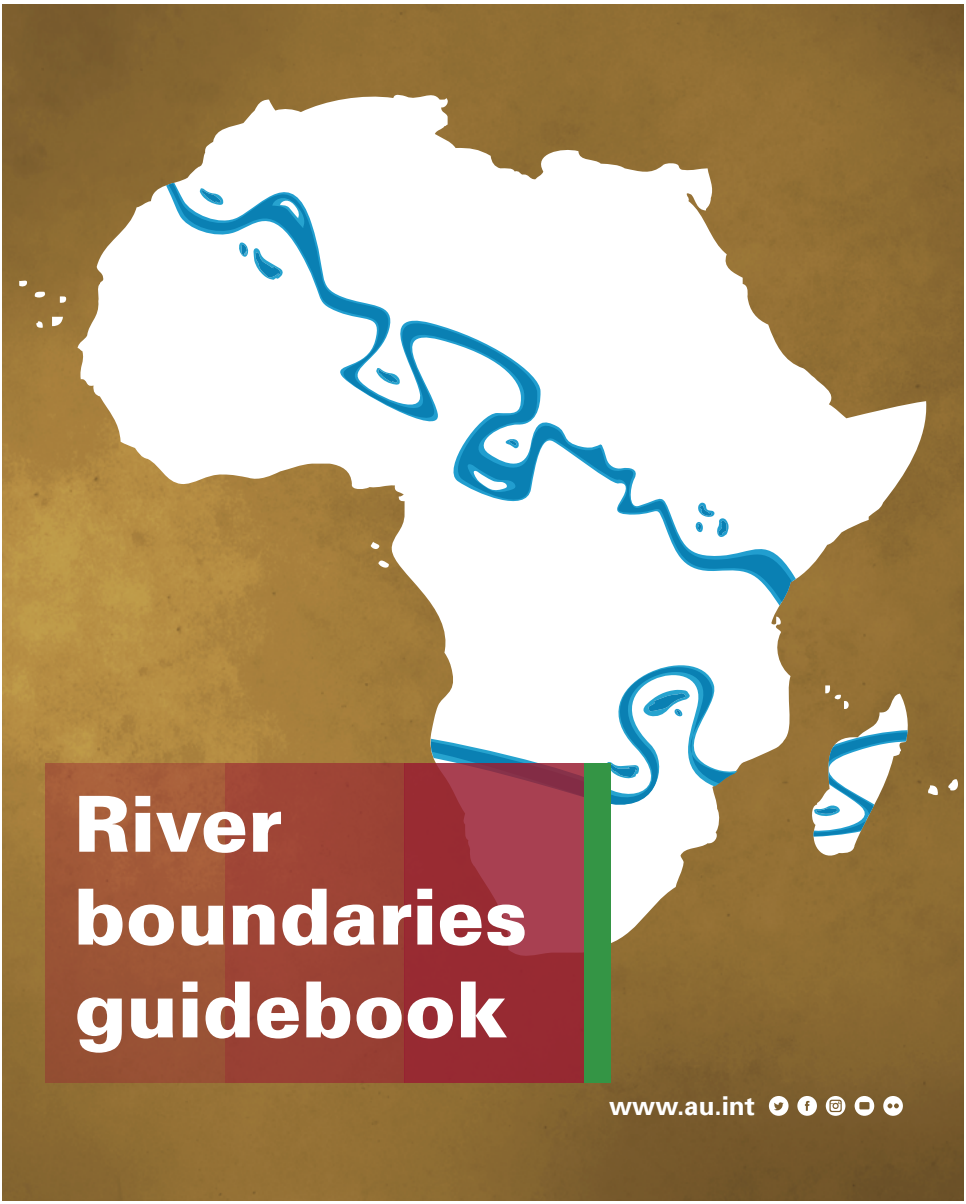
African Union

An Integrated, Prosperous and Peaceful Africa



River boundaries guidebook

www.au.int

African Union Headquarters P.O. Box 3243, Roosvelt Street, W21K19, Addis Ababa, Ethiopia **Tel:** +251 (0) 11 551 77 00 **Fax:** +251 (0) 11 551 78 44

Suggested citation: River boundaries guidebook, African Union, Addis Ababa, 2021

Addis Ababa, March 2021

Supported by German Foreign Office (AA) through
Deutsche Gesellschaft für internationale Zusammenarbeit (GIZ) GmbH.

1st edition, March 2021

African Union Commission
P.O. Box 3243
Roosevelt Street
Addis Ababa, Ethiopia

Tel: +251 11 551 3822
Fax +251 11 551 9321
Internet https://au.int
Twitter @_AfricanUnion / @AUC_PAPS

Responsible/Contact:
African Union Border Programme (AUBP)
Department for Political Affairs, Peace and Security
Email: Situationroom@africa-union.org
Tel. +251 11552 6373
Twitter: @AUC_PAPS
Facebook: https://www.facebook.com/au.paps
Website: http://www.peaceau.org

Design
Ira Olaleye, Eschborn, Germany

Maps
The maps printed here are intended only for information purposes and in no way constitute recognition under international law of boundaries and territories. AU nor the Authors accepts no responsibility for these maps being entirely up to date, correct or complete. All liability for any damage, direct or indirect, resulting from their use is excluded.

Addis Ababa, March 2021

german cooperation
DEUTSCHE ZUSAMMENARBEIT

Implemented by
giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

River boundaries guidebook

Foreword

Photo: © African Union

Rivers constitute a natural resource on which depend large swathes of the population in Africa. They constitute living areas around which local communities congregate and develop their economic, commercial, social, and cultural activities. They also form boundaries between two or more countries established at the time of the creation of colonial territories, commonly used as a convenient boundary between the possessions of the former colonizing powers. Thus, international river boundaries, circumscribing the territory within which the sovereignty of a State is exercised, ensure at the same time the subsistence of a large part of the African population. This dual function of river boundaries gives them common stakes that bind contiguous states and neighbouring communities. These actors can therefore interact by cooperating or fighting over the appropriation, control, access, and exploitation of this vital resource.

Political and diplomatic relations are sometimes thwarted due to a disagreement concerning the interpretation of the river boundary treaty and/or divergence on the delimitation approach. In some cases, good neighbourly relations between riparian populations deteriorate, especially when they diverge in the use of resources or

when the river changes its course over time. As with all disagreements between its Member States, the African Union Commission reiterates its appeal to use the mechanisms and instruments offered by the African Union and its Commission to prevent the escalation of disputes and to peacefully resolve conflicts arising from tensions between neighbours.

This guide is prepared by the African Union Commission, within the framework of the African Union Border Programme, to facilitate for the Member States and their experts in carrying out joint delimitation operations of their river boundaries. Clarifying the limits of river boundaries is a measure of structural conflict prevention and a step towards the establishment of a lasting climate of peace and stability.

The guide presents the physical characteristics of the rivers, makes an inventory of the legal considerations concerning boundaries, and draws up a typology of approaches of their delimitation. It offers useful hints and indications, the use of which by the Member States will help – I am sure – to contribute to the creation of peaceful, open, and prosperous African borders.

H.E. Amb. Bankole Adeoye
Commissioner for Political Affairs, Peace and Security
African Union Commission

Table of contents

List of abbreviations

AUBP	African Union Border Programme
AUC	African Union Commission
EEBC	Eritrea-Ethiopia Boundary Commission
GIS	Geographic Information Systems
GSWE	Global Surface Water Explorer
IBRU	Centre for Borders Research, Durham University
ICJ	International Court of Justice
ICL	International Law Commission
ILA	International Law Association
OAU	Organization of African Unity
Rc	Radius of curvature
UN	United Nations
UNECE	United Nations Economic Commission for Europe

1 Introduction – rivers as international boundaries

> *A river forms, so far as my experience goes, an excellent natural frontier, by far the best from the delimiter's point of view, for it requires no delimitation. A river delimits itself.*
>
> J.K. Trotter, 1897[1]

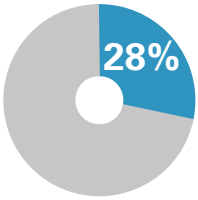
> *It is not merely because rivers change their courses or because their waters rise and fall that they provide awkward boundary markers; they necessarily of themselves provide no boundary line but only a boundary zone.*
>
> Judge Stephen, High Court of Australia, 1980[2]

> *It is perhaps unnecessary to point out that these problems of marking, maintenance, and administration sum up to an admonition that river boundaries be avoided wherever possible.*
>
> Stephen Jones, 1945[3]

[1] Trotter, J.K. (1897) 'The Science of Frontier Delimitation', *Minutes of Proceedings of the Royal Artillery Institution*, Volume 24, p. 209.

[2] Judge Stephen, High Court of Australia, *Ward v The Queen* [1980] HCA 11; (1980) 142 CLR 308 (1 May 1980).

[3] Jones, S.B. (1945) *Boundary-Making: A Handbook for Statesmen, Treaty Editors and Boundary Commissioners*, Washington, Carnegie Endowment for International Peace, p. 133.



of the total global boundary length follow rivers

~255,000 km land boundary worldwide

~71,000 km follow rivers

Views on the wisdom of choosing rivers as international boundaries vary considerably, as the comments above illustrate. What cannot be debated is that rivers have been popular choices as boundaries. Of the approximately 255,000 kilometres of international land boundary around the world, nearly 71,000 kilometres follow rivers – around 28% of the total global boundary length. 57 international boundaries (out of a global total of 321) follow rivers for more than 70% of their length, and 20 boundaries are at least 99% riverine. In Africa boundaries follow rivers for nearly 26,000 kilometres, 32% of the total continental boundary length. Every State on the continent apart from Egypt and the Sahrawi Arab Democratic Republic has at least one section of boundary which follows a river or a wadi, and six boundaries (Benin-Niger, Botswana-Zambia, Central African Republic-Democratic Republic of Congo, Côte d'Ivoire-Liberia, Mauritania-Senegal and South Africa-Zimbabwe) follow rivers for at least 99% of their length.[4] River boundaries may not be immediately obvious on small scale political maps but they are highly significant on the ground for many States around the world, including most African States.

[4] Statistics from IBRU: Centre for Borders Research's International River Boundaries Database (www.dur.ac.uk/ibru/resources/irbd). The Botswana-Zambia boundary in the Zambezi river is only around 160 metres long, connecting the Botswana-Namibia-Zambia and Botswana-Zambia-Zimbabwe tripoints (and precluding the possibility of the world's only international boundary quadripoint). The Zambia-Zimbabwe boundary was originally 100% riverine as well, but a section of the river was flooded to create Lake Kariba in 1958, turning a river boundary into a lake boundary. Although Egypt has no boundary rivers, its boundary with Sudan is straddled by Lake Nasser, which forms part of the Nile river basin which extends into 11 African States.

Figure 1.1 Major river boundaries of the world. The map depicts river boundary sections longer than 200 km or which constitute more than 70% of the boundary where they can be depicted at this scale. Many short river boundary sections cannot be depicted in a meaningful way on a small-scale world map. Data source: IBRU: Centre for Borders Research, Durham University; design: P. Hoffmann.

There are numerous reasons why so many international boundaries follow rivers. Some were chosen because they were viewed as 'natural' dividing lines between groups of people – even though the reality is that rivers often bring people together as much as they divide them. Some were chosen because they were considered easy to defend, or because they were easily identifiable and therefore inexpensive to demarcate. In many cases, both sides wanted access to the river for navigation, fishing or irrigation. Sometimes (particularly when European imperial powers were dividing up territory in Africa, Asia and South America in the late nineteenth century) rivers were the only mapped features in otherwise unknown landscapes, and therefore the only possible choice for a boundary apart from completely arbitrary straight lines.

However well-intentioned the choice of a river as a boundary may have been, in practice rivers create numerous challenges for boundary-makers. Many existing agreements relating to river boundaries in Africa simply describe the boundary as 'the river', which automatically creates uncertainty

over the location of the boundary. Even when a particular line within the river channel is specified in a boundary agreement – for example the middle of the main channel used for navigation or the median line between the banks – locating that line with precision is rarely a simple exercise. And even if the line can be identified, the neighbouring States have to address the fact that almost all rivers move over time. In tropical and sub-tropical climates rivers are often highly dynamic in nature, with significant seasonal variations in water level and frequent heavy floods that can dramatically reconfigure the river channel(s). A fundamental question for all States with river boundaries, therefore, is whether the boundary should move with the river or not? As a matter of principle, most States prefer fixed boundaries with defined turning points that never need to be altered. However, fixing a river boundary at a particular point in time will almost always mean that sooner or later the river will depart from the boundary, creating potential management challenges in relation to access to the river.

Different rivers can have very different characteristics, and the physical and human geography of the landscape through which a river runs can change significantly along its course. Even a single river boundary may therefore call for different delimitation and management approaches in different sections. In addition, every government has different priorities and different financial, technical and human resources. There is therefore no 'one size fits all' solution for river boundaries. However, there are certain issues that are relevant to nearly all river boundaries, and this guide book is designed to assist governments, technicians and scholars in thinking about those issues. The guide has been prepared in the context of the African Union Border Programme and should be especially relevant to African governments. However, river boundaries are found in all regions of the world and no aspect of river boundary definition or management is exclusive to Africa. The guide therefore draws on experience of river boundaries around the world and should be of interest to anyone whose work involves such boundaries.

The guide has been prepared by geographers, lawyers and boundary specialists with practical experience of river boundaries, international rivers and transboundary water resources.

Hydrology and river mechanics

Chapter 2 provides an overview of the physical characteristics and mechanics of different types of river, highlighting how river channels change along their course and over time.

Legal requirements in river boundary delimitation

Chapter 3 explores whether there are any rules relating to the definition of river boundaries under international law.

Issues to be addressed in river boundary agreements

Chapter 4 discusses issues that should be addressed in agreements relating to the definition of international boundaries in rivers, including: the location of the boundary in the river channel; the treatment of islands in boundary rivers; and how to deal with changes in the alignment of boundary rivers.

Use and Management of Transboundary Watercourses

Chapter 5 addresses the use and management of international rivers, both boundary rivers and rivers that cross international boundaries. The guide includes links to relevant online resources, conventions, agreements and legal cases, plus a list of recommended further reading for those who wish to explore the issues discussed in the guide in greater depth.

2 Hydrology and river mechanics

2.1 Introduction

A river is a mixture of water and sediment (soil, silt, sand, pebbles, etc) and ecosystems that is moving in a defined channel downstream through the river's catchment (which might also be called a drainage basin). In broad terms, the river channel can take one of three different forms (Figure 2.1). In upland areas, in a river's headwaters and in other steep sections of the catchment, the river will likely flow in a **bedrock channel**, between banks formed in the local bedrock (the local 'geology'). Rapid runoff from rocky valley sides means that such channels can exhibit a wide range of flow volumes (discharges), but the channel has a stable location between its bedrock edges. Secondly, moving downstream, channel slope flattens and the channel starts to be able to move sideways (laterally). The channel's lower gradient and its wider valley mean that sediment (alluvium) can be deposited in this wider valley and a floodplain can start to develop. Some parts of the river are still formed in bedrock and so the river has a **mixed bedrock/alluvial channel**. And thirdly, in the lower stretches the river flows in a floodplain with little or no bedrock in its bed or banks. The river's bed and banks are now formed completely of alluvium and the river is a fully **alluvial channel**. If a river's ultimate outlet is a lake or the sea, it may build a delta into that body of water (e.g., bottom right in Figure 2.1). The channel remains alluvial in the delta and will continue to function as an alluvial channel until, in the case of a marine delta, tidal influences begin to be felt, with reverse flows in the river and the effects of salt influencing the river's chemistry and sediments.

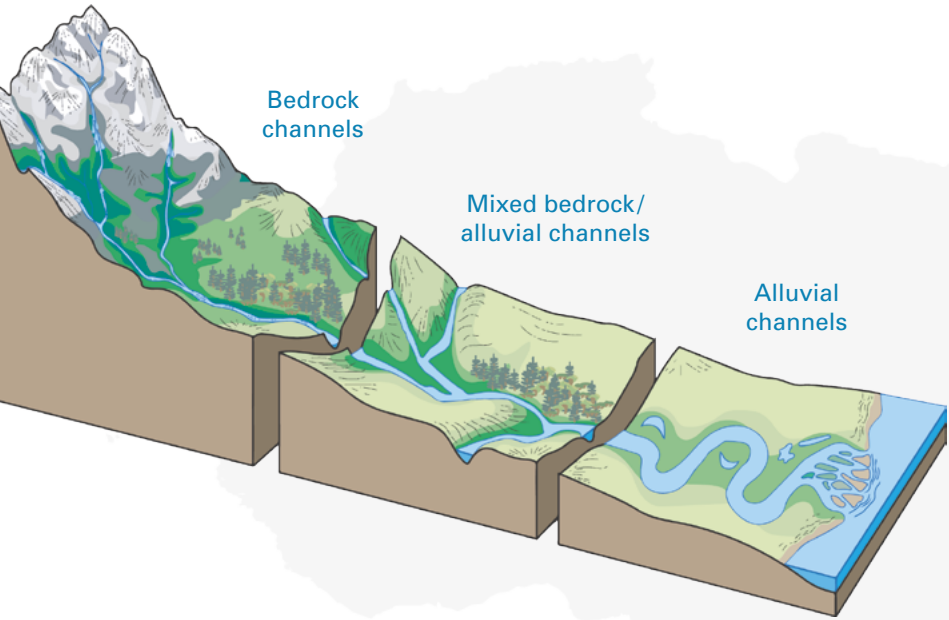


Figure 2.1 Diagrammatic representation of the three zones within a drainage system[5]

This three-part classification of channels – bedrock channel in the river's upper reaches or in areas of strong bedrock further downstream, mixed alluvial/bedrock channel in the middle reaches, alluvial channel in the downstream channel – is useful when thinking about river boundaries. Bedrock channels are generally stable in location and so make 'good' boundaries that are relatively straightforward to manage. A clear definition of the location of the boundary should therefore mean that the boundary is relatively easy to locate within a bedrock river. Thus, where the Caledon river marks the Lesotho-South Africa boundary between the sides of a bedrock valley, the channel's location is clear and appears to be stable; likewise the Zambezi river marking the boundary between Zambia and Zimbabwe in the gorge downstream of the Victoria Falls. If this riverine boundary is clearly defined with respect to the channel, the management of the boundary should be relatively straight-forward.

[5] Image adapted from: www.nps.gov/subjects/geology/images/3Zones_Fluvial_1204-2018_tte-01.jpg (original image: Trista L. Thornberry-Ehrlich, Colorado State University).

Mixed alluvial and fully alluvial rivers are less stable in form and location than a bedrock river. Such river types, where channel slopes are much gentler and the channel is liable to erode sideways into its floodplain sediments, present a range of issues when they are used to delimit boundaries (see chapter 4 for further discussion of river boundary definition and management).

2.2 Types of alluvial rivers

Alluvial rivers – rivers that are flowing within a floodplain composed of alluvium – can have several distinctive channel patterns (channel types). These channel types, summarised below, reflect the interaction of a range of factors, including:

- the slope of the channel and its valley;
- the amount of water the channel has to transport (i.e. the channel's discharge);
- the number and size of floods each year;
- the amount and type of sediment carried by the river;
- the type of sediment forming the channel banks;
- the vegetation of the channel banks; and
- the degree of human modification of these various factors.

Channels naturally evolve and change their position. Changes in the factors that control channel type can lead to increased rates at which the channel moves (changes its position), and even to changes to a different type of channel. Thus, in an era of global climate change, with changes in rainfall and hence river discharge, and of increasing populations that might lead to more engineering modifications of channels, increased channel instability can be expected. This instability can lead to issues with managing river boundaries.

There are many schemes of classification of rivers, but for our purposes, four main types are identified: straight, meandering, braided and anastomosing. Straight rivers are rather rare in nature and generally soon evolve into meandering channels or other forms; they are considered no further

here. Good starting points to assess what type of river you might be dealing with include imagery from Google Earth, ArcGIS Earth and Bing Maps (in 'Aerial' view), and such images are included in the discussion of each of the three river types below.

2.2.1 Meandering rivers

A **meandering channel** is a sinuous (winding or 'wriggly') single-thread channel (i.e. it consists of only one active channel). A meandering channel has a sinuosity (i.e. the ratio of down-channel distance to down-valley distance) greater than 1.5. That is, the distance down the channel between two points is at least 50% greater than the direct distance between those two points. For example, the Chobe river in the reach shown in Figure 2.2 has a sinuosity of 2.4. Figure 2.2 also illustrates two important characteristics of meandering channels:

(i) Meanders (i.e. the bends) in a meandering channel move sideways (i.e. laterally) across the floodplain by **accretion** (deposition) of sediment in a point-bar deposit. A point-bar is formed of the sediment progressively deposited on the inside bank of a meander bend as the channel migrates sideway (Figures 2.2 and 2.3, panels 1-3).
(ii) When such meander migration by accretion of point-bar deposits leads to a meander becoming very tight, the channel will break through the neck of the meander by **avulsion** (Figure 2.3, panel 4). This avulsion creates an **oxbow lake** (also known as a meander cutoff) and shortens the channel length.

The distinction between accretion and avulsion has frequently been used in relation to river boundaries. Many river boundary delimitations specify that when the channel moves relatively slowly by accretion, the boundary moves with the channel. When the channel changes position suddenly or abruptly by avulsion, however, the boundary stays where it was before the avulsion; see chapters 3 and 4 for further discussion of this aspect of river boundary definition. Braided rivers (see below) are much more likely to avulse than are meandering rivers, potentially leading to significant issues in managing boundaries that are located in braided rivers.

Figure 2.2 The meandering Chobe river just upstream of Kasane Airport, where the river marks the boundary between Botswana and Namibia. The river is a single-thread channel, with some other channels occupied during flood. The repeated curved lines on the inside of each bend mark successive positions of the channel as it moves sideways. Remnants of many ancient abandoned channel bends (meander cutoffs or infilled oxbow lakes) are found on the floodplain to the north of the present channel. Image: Google, CNES / Airbus.

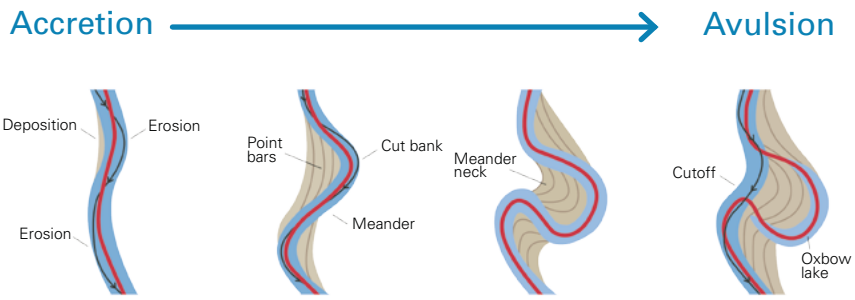


Figure 2.3 Diagram showing a boundary (red line, here shown as a median line boundary in the middle of the channel) moving with the channel when the channel changes position by accretion (deposition on the point bar on the inside of the bend) (panels 1-3). When the channel changes position by avulsion the boundary stays where it was before the avulsion (fourth panel).

A wide range of data from meandering rivers shows that various aspects of the river's morphology, including **channel width, channel depth** and **meander wavelength** (the distance from meander crest to meander crest) are closely related to **bankfull discharge**. Bankfull discharge is the flow that just fills the channel to the tops of its banks (just before the river floods out over the floodplain). This bankfull discharge occurs in meandering streams about once every two to two-and-a-half years. Data show that channel width, channel depth and meander wavelength all increase systematically with increasing bankfull discharge. This means that the bigger the river, with a higher bankfull discharge, the wider and deeper is the river, with a longer meander wavelength. Bankfull position on the channel is the tops of the banks where the channel is 'full' and any increase in water depth leads to the river flowing out onto the floodplain.

An important issue for managing a meandering river boundary is the expected rate of lateral (sideways) movement of the meander by lateral accretion (i.e. by the ongoing natural deposition of sediment on the point bar on the inside of the bend). A large world-wide data set shows broadly that the larger the river, the higher the rate of meander migration (Figure 2.4). Annual **meander migration rates** for a channel in a given catchment area can range over an order of magnitude, however, and even higher in one or two cases. Thus this relationship, being rather scattered, can be taken as indicative only. Nonetheless, the rate of meander migration in the Semliki river, where it forms the Democratic Republic of the Congo-Uganda boundary from Yenga to Lake Albert, shows a migration rate of about 1.5 m/year, averaged through that reach between 2002 and 2014 (Figure 2.4).[6] This is a relatively low rate of meander migration for its catchment area.

[6] Davies, S. (2014) *The use and stability of riverine boundaries in Africa with reference to channel type; the Congo and the Semliki Rivers*, Undergraduate Bachelors Honours Dissertation, School of Geographical & Earth Sciences, University of Glasgow.

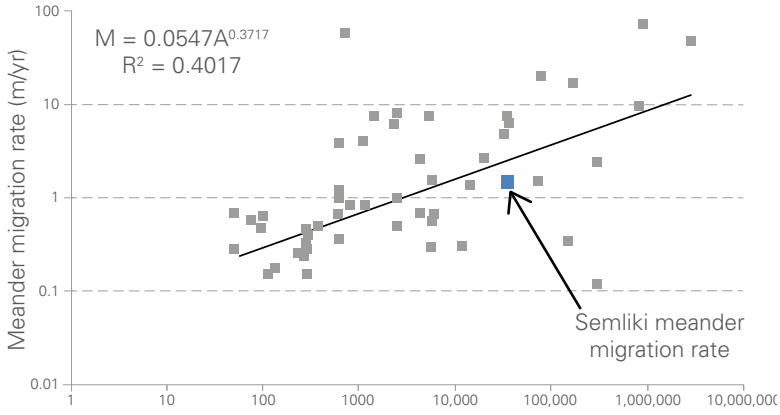


Figure 2.4 Meander migration rate versus catchment area[7]

Figure 2.4 uses catchment area as a substitute measure of river flow (discharge). This procedure is followed because discharge data are not readily available for many rivers, and catchment area can be calculated easily from free global elevation datasets. The scatter in the data in Figure 2.4 partly reflects the fact that catchment area is not a perfect substitute for discharge. A given river catchment might, for example, be in a high rainfall setting with a high discharge for its catchment area, or in a tropical setting with an even higher discharge for the catchment area. On the other hand, a river in a semi-arid setting has a low discharge for its catchment area. And so rates of channel migration are scattered about the line-of-best-fit according to their actual discharge.

A more precise indication of which meanders might be expected to have higher rates of migration is given by **a meander's radius of curvature (Rc), normalised (divided) by the channel width (w)** (Figure 2.5). Rc has to be normalised by channel width, w, because, as Figure 2.4 shows, higher migration rates would be expected in larger rivers (which have larger meanders). The data in Figure 2.5 show that maximum rates of bend migration are to be expected when Rc/w is about 2 to 3. In other words, the simple exercise of measuring Rc and w off aerial images or maps can

[7] Graph from data supplied by Professor Ian Rutherfurd, University of Melbourne.

indicate which bends might be expected to migrate more rapidly and thus the bends that might need to be monitored for migration and hence for possible boundary issues.

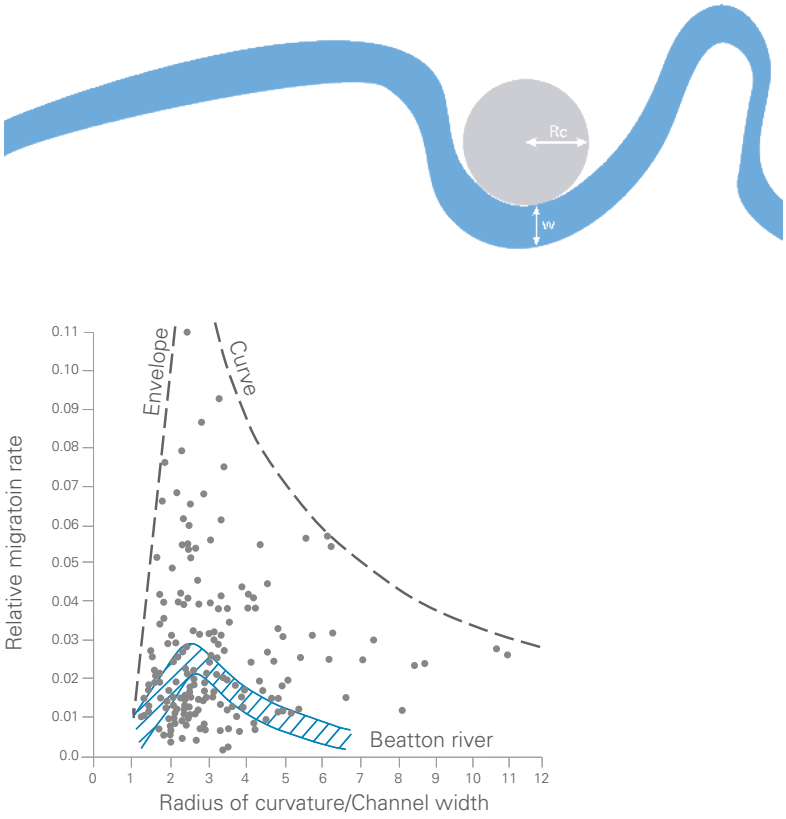


Figure 2.5 Top: Meander bend radius of curvature (Rc) and channel width (w). Bottom: Relationship between rate of channel migration (metres per year) and normalised meander bend radius (the meander's radius of curvature divided by the channel width at the meander: Rc/w) for Beatton river, Canada (shaded area) and for 17 other rivers. Note that the maximum rates of meander migration coincide with Rc/w ratios of 2 to 3. This relationship has been shown to hold for other regions and is a general finding of the computer modelling of Crosato.[8]

[8] Crosato, A. (2009) 'Physical explanations of variations in river meander migration rates from model comparison', *Earth Surface Processes and Landforms* 34. Graph redrawn from Nanson, G.C. and Hickin, E.J. (1986) 'A statistical examination of bank erosion and channel migration in western Canada', *Bulletin of the Geological Society of America* 97.

Meander migration rate is also determined by the **types of sediment** that form the channel banks and the type and amount of vegetation. Finer sediments (clays and silts), being more difficult to erode, promote stable banks with slower rates of meander migration. Vegetation also promotes bank stability and slower rates of meander migration.

The line of deepest water in a river channel is usually called the thalweg. In a meandering channel, the **thalweg** follows a more meandering line than the channel itself, swinging from side to side in the channel. It passes through pools on the outside of each channel bend and crosses the channel between the pools at riffles (Figure 2.6). The channel is shallower at the riffles. The river erodes the outside bank at meander bends (at the pools) and the eroded sediment is deposited on the inside of the next meander downstream, in the point bar. Many river boundary agreements stipulate that the boundary follows the thalweg. This practice probably reflects the historical importance of passage along rivers by large trading boats, which had to follow the line of deepest water. A boundary following the thalweg thus allows both States to use the river for navigation and thus trade.

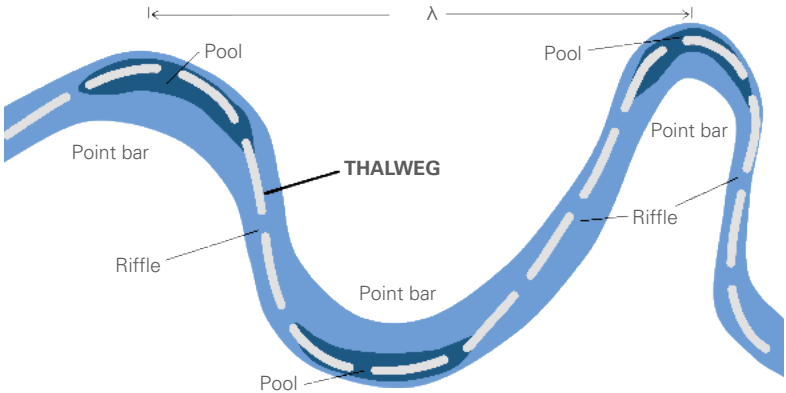


Figure 2.6 Diagram showing the locations of pools and riffles in the meander bends from Figure 2.4, and the path of the thalweg, swinging from side to side along the channel, from pool to pool on the outsides of bends. λ (at top) marks the meander wavelength.

2.2.2 Braided rivers

Braided rivers are multi-channel rivers, with many channels that often switch and change position (Figure 2.7). Braided rivers are steeper than meandering rivers for the same discharge (Figure 2.8). It can also be seen from Figure 2.8 that for a given slope, braided rivers have a higher discharge than do meandering rivers on the same slope. Discharge in braided rivers also tends to have higher peaks and to be more variable. Higher and more variable discharges are associated with, for example, semi-arid and arid regions where maximum flows fed by intense, high rainfall storms.

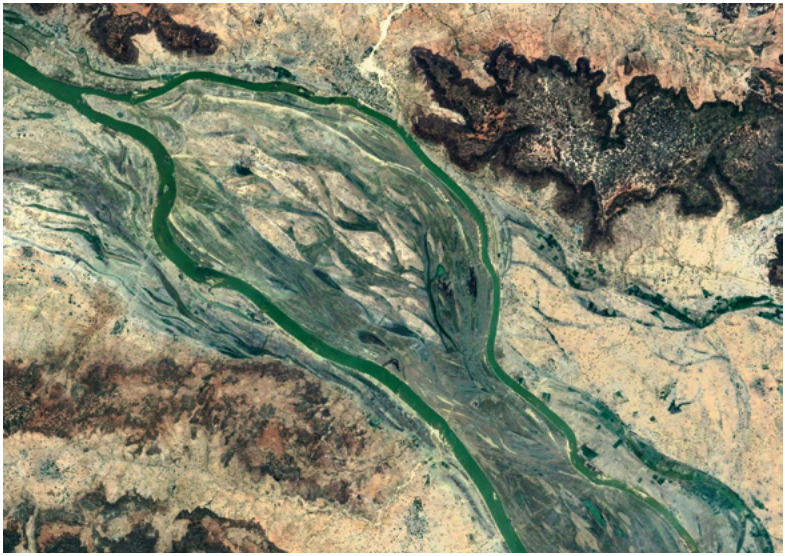


Figure 2.7 The multi-thread braided channel of the Niger river where it marks the boundary between Benin and Niger near Ouna, Niger. Image: Google, CNES/Airbus.

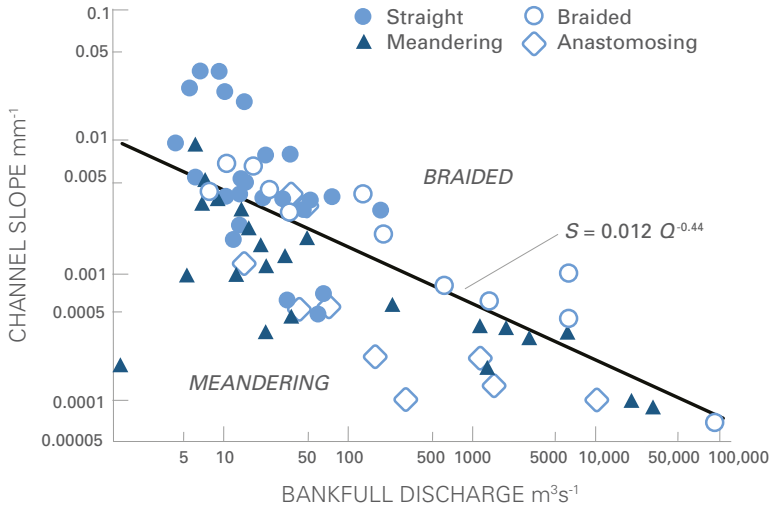


Figure 2.8 Plot of channel slope versus bankfull discharge for straight, meandering, braided and anastomosing channels. The straight line separates single-thread meandering channels from multi-thread braided channels.[9]

Arid and semi-arid settings also often have only sparse vegetation stabilising river banks, and in such settings the sediment carried by rivers is often coarse (sands and gravels). This is because drier settings have less chemical weathering to break rock down into the clays and silts that are characteristic of many meandering streams and which are more resistant to erosion in the channel banks. This combination of

(i) coarse sediment that is more erodible,
(ii) less vegetation on the river banks, and
(iii) high peak discharges,

means that channel banks are less stable and river flow can more easily erode the banks. In other words, in braided rivers the main flow frequently switches from one channel to another by avulsion. The individual channels of a braided rivers are generally not suited to being boundaries because it is not necessarily clear which channel marks the boundary (Figure 2.7). As

[9] Graph redrawn from Knighton, D. (1998) *Fluvial Forms and Processes: A New Perspective*, London: Hodder Arnold, Figure 5-17A.

well, a braided river's frequent switching of channels by avulsion means that one channel might not be the main channel for very long.

2.2.3 Anastomosing rivers

An **anastomosing** river is, like a braided river, a multi-thread channel but the banks of anastomosing rivers are fine-grained and well vegetated. The islands in an anastomosing channel are also well vegetated and generally stable (Figure 2.9). Anastomosing channels generally have fine-grained sediment loads, generally gentle flow (low stream power) and low to very low gradients (see Figure 2.8 where most of the anastomosing channels are in the low gradient part of the data). These factors combine to produce channels that are generally stable.

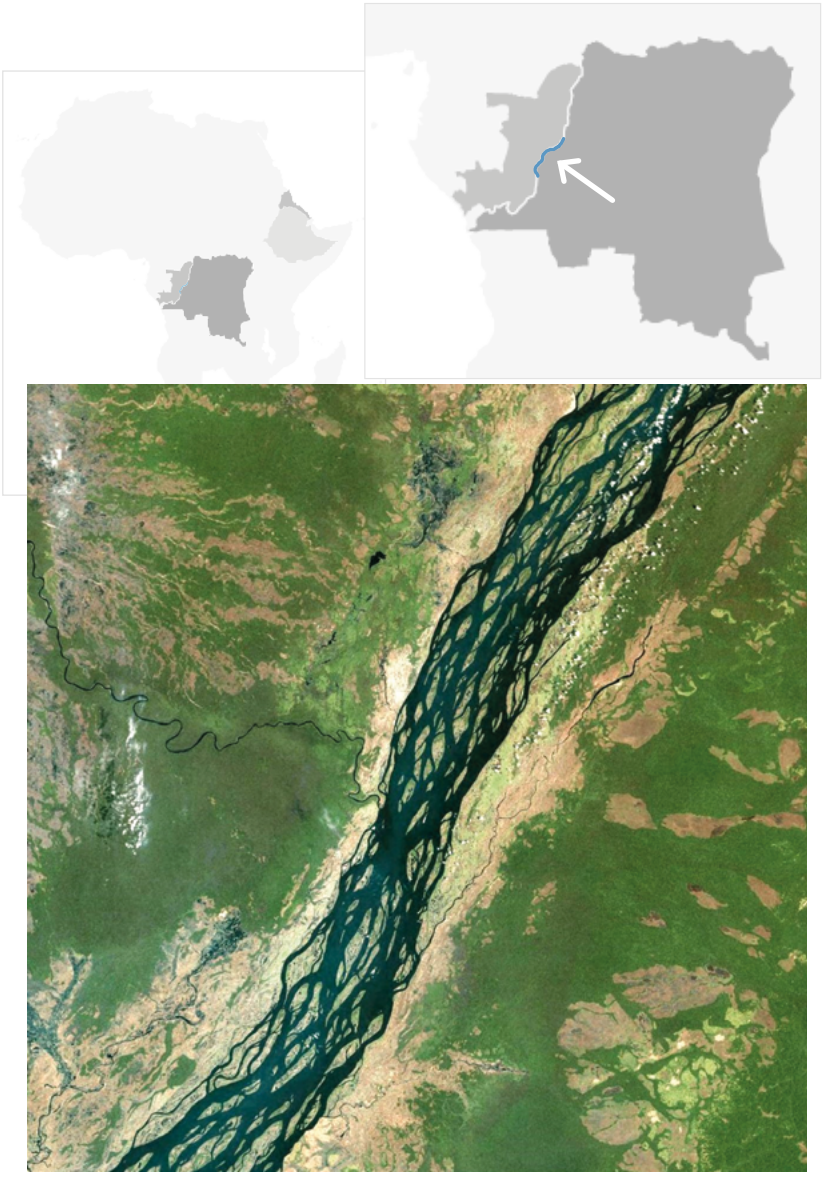


Figure 2.9 The Congo river where it marks the boundary between the Republic of the Congo (on the left in this image) and the Democratic Republic of the Congo (on the right in this image). The Congo here has an anastomosing channel form – a multi-thread channel with islands that satellite imagery shows have been stable in this reach for some decades; flow is to the south. Zooming in on this image confirmed that the islands are well vegetated. Image: Microsoft, Earthstar Geographics.

2.2.4 Alluvial rivers – conclusion

Rivers are the result of the interaction of a complex set of physical factors and it is not yet possible to produce a definitive answer to the question as to why a river has its particular form (i.e. meandering, braided or anastomosing). One important general lesson is that alluvial rivers (i.e. rivers flowing within banks composed of sediment in a floodplain) are naturally inclined to move about and change position. The meanders in a meandering river migrate sideways naturally and in a braided river the main flow (the deepest water) often switches naturally between different channels. The channel banks of braided rivers are generally unstable and liable to erode and move about. Anastomosing rivers are multi-thread, like braided rivers, but they tend to have stable channels and banks (reflecting their low gradient and fine-grained sediment load). The channel in a river delta can be treated in the first instance as the alluvial channel that it is. It would be expected to function consistently within the overall framework of alluvial channels as outlined here.

Plotting the properties of a particular river on diagrams such as those in Figures 2.4, 2.5 and 2.8 and with other datasets in the literature should provide insight as to why the river has the form it does. Recent advances in numerical modelling of channel form offer possibilities in this regard. However, the outcomes of such modelling remain general and not specific to any one river. It is also important to remember that the relationships between various river characteristics that are displayed in the diagrams in this chapter are often quite scattered and rather imprecise. This reflects the nature of the science of complex systems such as rivers, where multiple factors – amount of flow and its variability and seasonality, valley slope, total sediment load, type of sediment, nature and amount of vegetation on the channel banks, and so on – combine to give a particular river its particular character. Nonetheless, rivers do exhibit systematic order amid the complexity, and it is this order that can help us to understand how a particular river and boundary associated with it might behave.

2.3 Seasonally fluctuating rivers as a particular class of rivers

Many African rivers are fed by **highly seasonal rainfalls** (the so-called African monsoon) and/or they flow through semi-arid regions. Such climates are associated with a wide range of channel discharges, which are frequently high to extreme during semi-arid or monsoonal thunderstorms. Such conditions, combined with the channel banks' often sparse vegetation cover and the channels' coarse-grained sediment load, mean that these channels are frequently braided and hence likely to be unstable with much switching of the flow between different channels of the braided river.

2.4 Climate change

We have seen above that a **major determinant of both channel size and channel type is discharge**, the flow that the river has to accommodate: the higher the discharge, the larger the river channel (deeper, wider and longer wavelength). So, if discharge changes as a result of, for example, climate change (increasing or decreasing discharge according to how rainfall and catchment conditions change), then the channel dimensions will be expected to change accordingly. As the data in Figure 2.10 indicate, if discharge increases enough in a meandering river that plots close to the dividing line between meandering and braided meandering rivers on the plot, we expect that the river will have a tendency to become braided. Changes to discharge as a result of human activities, especially the building of dams or the diversion of water for, say, irrigation, will also be expected to have an impact on channel characteristics. Dam building and water extraction for irrigation generally lead to a decrease in discharge and hence a shrinking of the channel (and a potential impact on the location of a riverine boundary). Dam construction generally leads to the cutting-off of sediment to the channel downstream of the dam because that sediment is likely to be trapped in the dam. This decrease in sediment to the channel can lead to associated changes in the channel.

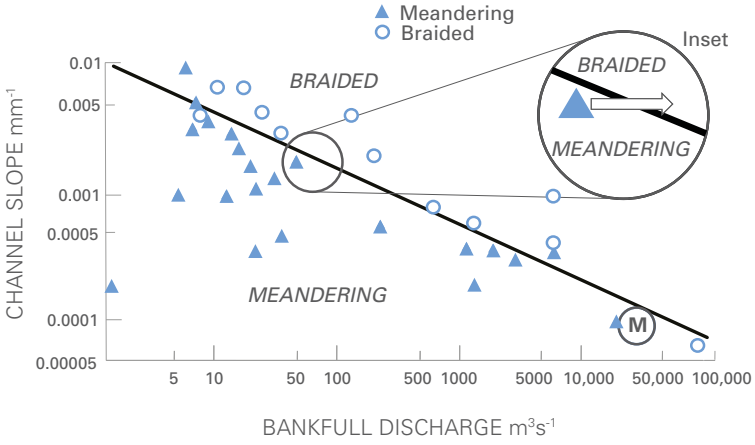


Figure 2.10 Top: Simplified plot of data from Figure 2.8. Any of the meandering rivers (triangle symbols) that plot close to the line separating meandering and braided streams might be expected to show a tendency to become braided if discharge increases enough to push the river across the threshold between meandering and braided (e.g., the increase in discharge indicated by the arrow in the inset). The circled M at lower right plots the position of the Mekong river, which forms the boundary between Laos and Thailand near Vientiane (shown in the bottom image). In the top plot, the Mekong falls close to the threshold line between the two channel types. This is consistent with the Mekong in this reach mainly showing meandering characteristics but also showing some characteristics of a braided stream, especially well-developed mid-channel islands (upper left, lower centre, centre right in the lower image). The channel seems to be on the threshold between meandering and braided, and any increase in discharge might be expected to push the river towards a more braided channel type. Conversely, decreasing discharge, as a result of, say, dam building upstream, might be expected to lead to a smaller meandering stream perhaps without the mid-channel islands. [10]

[10] Graph from Gregory, K.J. and Walling, D.E. (1973) *Drainage Basin Form and Process*, London: Edward Arnold, Figure 5.5A. Image: Google, Maxar Technologies.

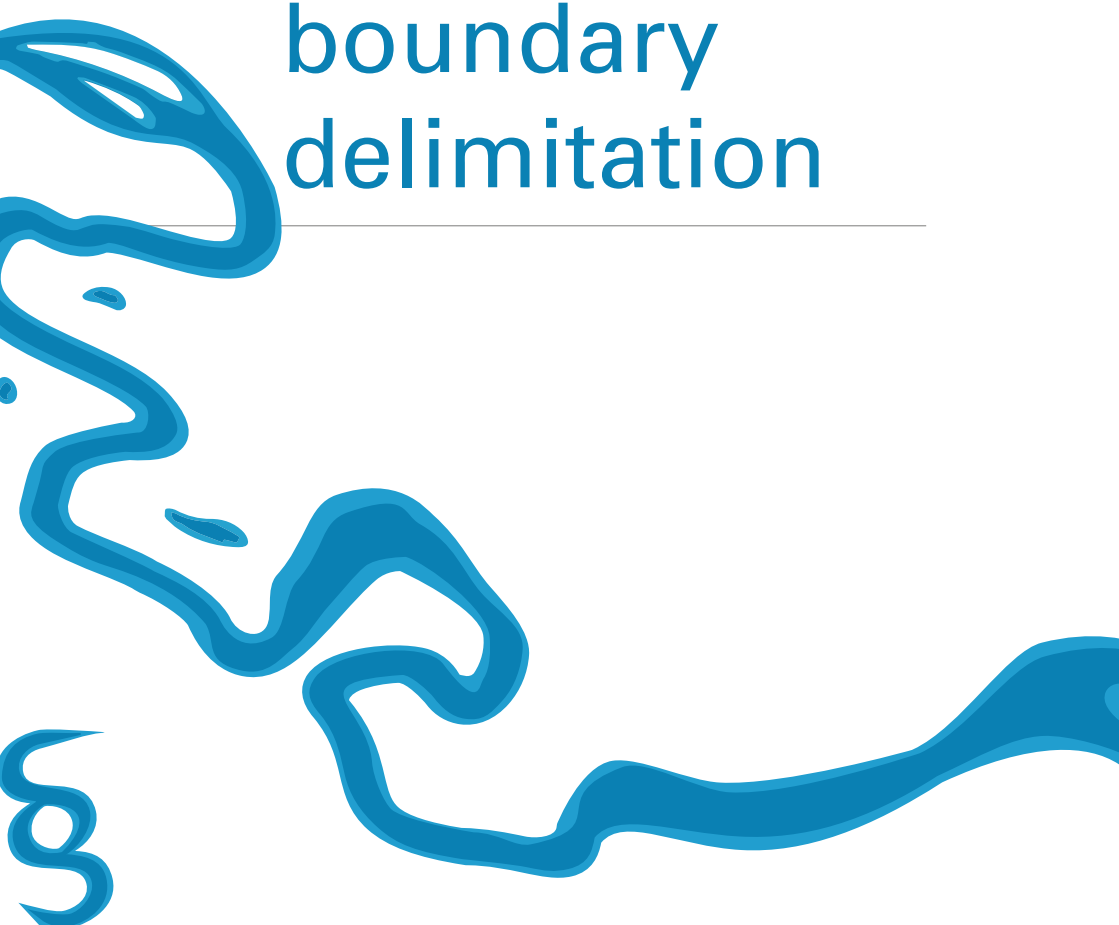
2.5 Summary

The important characteristics of the different river types are summarised in the following table:

Table 2.1 Summary of the characteristics of the three main river types considered in this chapter

Channel type →	Meandering	Braided	Anastomosing
Overall character	Single thread (one channel)	Multiple channels (i.e. many channels separated by low islands)	Multiple channels with well-vegetated islands
Channel cross-sectional form	Lower width-depth ratio (narrower and deeper compared to the other river types)	High width-depth ratio – the wide channel track consists of multiple shallow channels	Overall high width-depth ratio (i.e. a wide channel track) consisting of multiple relatively narrow deep channels
Channel slope (gradient)	Lower gradients (channels have gentle slopes)	Higher gradients (channels have steeper gradients)	Very low slopes (gentle gradients)
Channel flow (discharge)	Lower & less variable discharges than braided river with the same gradient	Higher discharges in general and higher peak discharges	Variable discharges depending on the climate regime
Sediment load	Mixed grain-size sediment (sand, clay and mud)	Generally coarse-grained sediment load (sands and gravels)	Fine-grained sediments (sand, clay and mud)
Channel banks	Finer-grained & vegetated channel banks that are relatively more stable than the banks of a braided river	Coarse-grained banks (sands and gravels) that are generally not well vegetated and are easily eroded	Fine-grained sediments (clays and muds) with generally well-vegetated, stable banks
Stability	Change is generally relatively slow and steady by meander migration, with meander cutoffs causing sudden channel change	High discharges and erodible banks mean that channel switching is common and characteristic of braided rivers	Channels generally very stable in location

3 Legal requirements in river boundary delimitation



3.1 Sources of international law

Five sources of international law are identified in the statute of the International Court of Justice (ICJ). The two primary sources are:

(i) international conventions, whether general or particular, which have established rules expressly agreed upon by the concerned States; and
(ii) international custom, as evidence of a general practice accepted as law.

The general principles of law recognized by civilized nations are a third source, with judicial decisions and the teachings of the most highly qualified publicists of the various nations listed as a subsidiary means for the determination of rules of law.[11] Do any of these sources provide rules or principles for the delimitation of river boundaries?

3.2 Absence of conventional law on river boundary delimitation

There is certainly no international convention which addresses the definition of river boundaries, even in the general way that the United Nations Convention on the Law of the Sea addresses the delimitation of maritime boundaries.[12] The United Nations Convention on the Law of the Non-navigational Uses of International Watercourses contains provisions which may be relevant to boundaries in rivers (see chapter 5) but it does not address river boundary definition in any way.

[11] International Court of Justice, *Statute*, Article 38 (www.icj-cij.org/en/statute and www.icj-cij.org/fr/statut).

[12] Articles 74 and 83 of the United Nations Convention on the Law of the Sea call for exclusive economic zone and continental shelf boundaries to be agreed on the basis of international law in order to achieve an equitable solution.

3.3 Absence of customary law on river boundary delimitation

Customary international law has succinctly been described as 'rules of law derived from the consistent conduct of States acting out of the belief that the law required them to act that way.' [13] Even a cursory survey of State practice with regard to river boundaries reveals a significant range of approaches to delimitation. It is therefore very difficult to imagine that any State could perceive an international pattern of practice so consistent that it creates a sense of obligation to adopt a certain delimitation methodology – although not all scholars of international river boundaries agree (see chapter 3.7).

3.4 Absence of relevant general principles of law

The scope of the 'general principles of law' is far from clear, but examples include principles of consent, reciprocity, equality of States, finality of awards and settlements, the legal validity of agreements, good faith, domestic jurisdiction, and the freedom of the seas. [14] Such general principles are unlikely to be of much help in clarifying the location of an international boundary in a river.

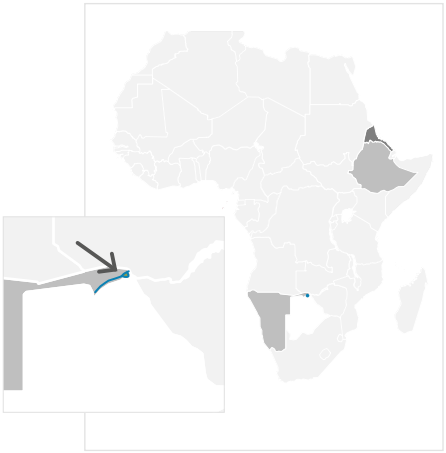
[13] Rosenne, S. (1984) *Practice and Methods of International Law*, New York, Oceana Publications, p. 55.

[14] Crawford, J. (2012) *Brownlie's Principles of Public International Law*, 9th Edition, Oxford: University Press, p.37.

3.5 Approach of the International Court of Justice to river boundaries

The International Court of Justice has addressed river boundaries on several occasions. Most of the Court's decisions in cases concerning river boundaries relate to the specific characteristics of the rivers in question and the treatment of those rivers by the parties to the dispute. However, in the course of analysing the claims of the parties in those cases, the Court offered a number of observations which are relevant to river boundaries in general.

In the **Kasikili/Sedudu Island (Botswana/Namibia)** case, the Court offered a general observation on how States approach the definition of boundaries in navigable and non-navigable rivers:



> *Treaties or conventions which define boundaries in watercourses nowadays usually refer to the thalweg as the boundary when the watercourse is navigable and to the median line when it is not, although it cannot be said that practice has been fully consistent.*[15]

[15] *Case Concerning Kasikili/Sedudu Island (Botswana/Namibia)*, Judgment, 1999, paragraph 24 (https://www.icj-cij.org/files/case-related/98/098-19991213-JUD-01-00-BI.pdf).

In the **Frontier Dispute (Benin/Niger)** case, the Court went a little further, indicating that a boundary following the median line of the Mekrou river was appropriate at least partly because the river was not navigable:

> *The Chamber notes that in all likelihood there is a negligible difference between the course of the thalweg and the course of the median line of the Mekrou river, but considers that, in view of the circumstances, including the fact that the river is not navigable, a boundary following the median line of the Mekrou would more satisfactorily meet the requirement of legal security inherent in the determination of an international boundary.*[16]

In the same case, the Court was asked not only to identify the location of the boundary in the Niger and Mekrou rivers, but also to determine sovereignty over islands in the Niger river. Having determined that the boundary in the Niger follows the main navigable channel as it existed at the dates of independence (mainly on the basis that the main navigable channel had been recognised as the boundary for a significant period prior to independence), the Court determined sovereignty over islands in the river primarily according to which side of the boundary each island was located. However, the Court also considered whether any *effectivités (*acts undertaken in the exercise of State authority through which a State manifests its intention to act as the sovereign over a territory) justified either State being awarded sovereignty over any islands which lay on the 'wrong' side of the boundary. In the case of the Benin-Niger boundary no islands fell into that category.

In the **Land, Island and Maritime Frontier Dispute (El Salvador/Honduras: Nicaragua intervening)** case, El Salvador claimed that a major avulsion had taken place in the Goascoran river at some point in the past. El Salvador argued that, as a matter of law, this meant that the boundary should follow the original channel of the Goascoran rather than its current

[16] *Case Concerning the Frontier Dispute (Benin/Niger)*, Judgment, 2005, paragraph 144 (www.icj-cij.org/files/case-related/149/149-20130416-JUD-01-00-BI.pdf).

course. The Court rejected El Salvador's claim partly on the grounds that there was no evidence that an avulsion had taken place, and partly on legal grounds relating to *uti possidetis juris* and the conduct of the two States. However, it did not directly reject the legal principle concerning accretion and avulsion that El Salvador had argued:

> *… El Salvador's argument of law is that where a boundary is formed by the course of a river, and the stream suddenly leaves its old bed and forms a new one, this process of 'avulsion' does not bring about a change in the boundary, which continues to follow the old channel. No record of such an abrupt change of course having occurred has been brought to the Chamber's attention, but were the Chamber satisfied that the river's course was earlier so radically different from its present one, then an avulsion might reasonably be inferred. While the area is low and swampy, so that different channels might well receive different proportions of the total run-off at different times, there does not seem to be a possibility of the change having occurred slowly by erosion and accretion, to which, as El Salvador concedes, different legal rules may apply.*
>
> *… On this basis, what international law may have to say, on the question of the shifting of rivers which form frontiers, becomes irrelevant: the problem is mainly one of Spanish colonial law. In fact, the alleged rule originated in Roman law as a rule applicable to private property, not as a rule relating to rivers as boundaries of jurisdiction and administration. Furthermore, whatever its status in international law – a matter to be determined, if necessary, by the Chamber, on the basis of the principle of jura novit curia –, its possible application to the boundaries of Spanish colonial provinces would require to be proved.*[17]

[17] *Case Concerning the Land, Island and Maritime Frontier Dispute (El Salvador/Honduras: Nicaragua intervening)*, Judgment, 1992, paragraphs 308 and 311 (www.icj-cij.org/files/case-related/75/075-19900913-JUD-01-00-BI.pdf).

These comments and conclusions suggest that, in the absence of other relevant circumstances that might justify an alternative decision, the ICJ would probably adopt the following positions regarding river boundaries:

1. If the location of the boundary in the river is not already agreed, in navigable rivers (or navigable sections of rivers) the boundary will follow the thalweg and in non-navigable rivers/sections the boundary will follow the median line between the banks.

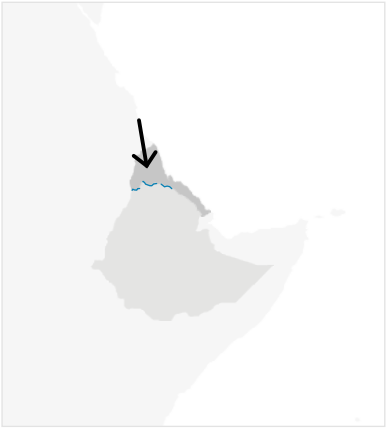
2. Sovereignty over islands in boundary rivers will most likely be determined by the location of the islands relative to the boundary. However, *effectivités or other evidence of title may also be significant in terms of determining sovereignty.*

3. If there is no agreement concerning what happens to the boundary if the river channel moves, the boundary will move with the river channel if the movement of the channel is the result of accretion, but it will continue to follow its old course if the channel shifts due to a sudden avulsion.

However, just because the ICJ is likely to take a certain approach in certain circumstances does not mean that a legal principle has been established which other States are obliged to follow. Indeed, it is notable that the Court has had opportunities to declare the existence of legally binding rules or principles regarding river boundary definition, but it has chosen not to do so. This suggests that the ICJ considers that there is no customary international law on river boundary delimitation, and that its decisions have been – and should be – made on a case by case basis.

3.6 Approach of other international judicial bodies to river boundaries

The 1911 **Chamizal arbitration** award concerning a disputed tract of land in the Rio Grande between Mexico and the United States of America is often cited as being relevant to the question of whether a river boundary moves with changes in the river due to accretion but continues to follow the old course of the river if the channel moved due to avulsion. The implications of accretion and avulsion for river boundaries were certainly a central element of the arbitration. However, the dispute was not really about whether there was an accretion/avulsion rule in international law which applied to the boundary in the Rio Grande. Rather, it was about whether the provisions of an 1884 treaty between Mexico and the United States (which established an accretion/avulsion rule in respect to the boundary between the two States) should be applied retroactively to changes in the river that took place prior to the entry into force of that treaty. It is interesting to note that the arbitral award mentioned that both parties considered the effects of accretion and avulsion on boundaries to be 'well known principles of international law' but otherwise the Chamizal arbitration is unlikely to be of much relevance for river boundaries in Africa.



The **Eritrea-Ethiopia Boundary Commission** (EEBC), which delimited and notionally demarcated the boundary between Eritrea and Ethiopia between 2000 and 2007, was not technically a judicial body. However, its proceedings during the delimitation phase were very similar to those of an arbitral tribunal and the parties agreed that its determinations would be final and binding. Over half of the 1,039 km Eritrea-Ethiopia boundary follows rivers. Although the two governments disagreed over which rivers the boundary followed, both agreed that in principle the boundary should follow the main channels of the rivers forming the boundary. In the delimitation phase the Commission ruled that the boundary in rivers should be determined by reference to the location of the main channel, and that the main channel should be

identified during the dry season. It also noted that regard should be paid to the customary rights of the local people to have access to the river.[18] During the demarcation phase, the Commission ruled that:

> *(a) the identification of a river, as a boundary, should normally suffice without actual demarcation therein save as regards the identification of such turning points as might otherwise give rise to doubts, and of headwaters or sources;*
>
> *(b) the boundary is the middle of the main channel (the channel of greatest volume) and will move in accordance with any change in position of the middle of the main channel;*
>
> *(c) the middle of the main channel, as defined in (b) above, shall not be demarcated;*
>
> *(d) islands shall fall within the territory of either Party according to their location in relationship to the main channel.*[19]

The 1:25,000 scale maps prepared by the EEBC depict the outer banks of the rivers in which the main channel will be found, but identification of the

[18] Eritrea-Ethiopia Boundary Commission, Decision regarding delimitation of the border between Eritrea and Ethiopia, 13 April 2002, p.95 (http://legal.un.org/riaa/cases/vol_XXV/83-195.pdf).

[19] Demarcation instructions of 22 August 2003, UN Document S/2005/142, Enclosure 4 (https://undocs.org/en/S/2005/142). The Commission further ruled that at confluences, 'where topography permits, the turning point shall be identified by three pillars, one on each bank of the river that meets the other and the third on the bank of the latter opposite the confluence, with the distances of each pillar from the point of meeting being marked thereon.' References to the headwaters or sources of rivers or streams meant 'the highest point at which the flow of water can be identified or, if the stream bed has become permanently dry, then the highest point at which the stream bed can be identified.' (Demarcation Directions of 8 July 2002, as revised November 2002, March and July 2003; UN Document S/2005/142, Enclosure 2).

precise location of the main channel in each river section was ultimately left to the two governments.

The EEBC gave no indication that it was following any established principles of international law in its approach. It noted that its decision that the boundary would follow the main channel reflected the wishes of the parties, and it is likely that its other decisions relevant to river boundaries were the product of a pragmatic approach in difficult circumstances (e.g. the Commission was unable to send surveyors to inspect the boundary on the ground during the demarcation phase). Nevertheless, the Eritrea-Ethiopia boundary provides an interesting case study in river boundary definition from which other States may be able to draw some useful lessons and ideas.

3.7 The 'teachings of the most highly qualified publicists' on river boundaries

The body of academic literature on river boundaries is not vast, but it is sufficiently extensive to prevent a comprehensive review of the views of the 'most highly qualified publicists' in this guide book. In summary, however, scholars are divided over whether there are international law rules relating to the definition of river boundaries.

When there is no agreement indicating the location of the boundary in the river or what happens to the boundary if the river moves, some scholars have argued that: (i) the boundary automatically follows the thalweg in navigable rivers and the median line in non-navigable rivers; and (ii) the boundary moves with changes due to accretion but stays in the old

river channel following an avulsion.[20] However, in most cases where the existence of one or both 'rules' is posited, little evidence is provided to support the assertion. Other scholars are more cautious, noting that there is some support for the existence of these rules in the literature on river boundaries, but warning that there are numerous examples of alternative practice. Generally, the more in-depth the review of State practice around the world, the more likely the author is to conclude that the argument that customary rules exist is at least debatable.[21]

3.8 Respect for inherited boundaries

One of the earliest resolutions of the Organization of African Unity's first assembly of heads of State and government in 1964 was that member States would 'respect the borders existing on their achievement of national independence'.[22] Aimed at preventing border wars and the breaking up of independent States into smaller countries or kingdoms, the principle of respect for inherited boundaries remains a central pillar of the African Union Border Programme today.

[20] The 'rule' concerning accretion and avulsion in particular has some notable supporters, beginning with Hugo Grotius (who is often described as the 'father of international law') who first set out the principle in 1625, deriving his arguments from Roman property law (see Grotius, H. (1625) *The Rights of War and Peace*, available at https://oll.libertyfund.org/titles/grotius-the-rights-of-war-and-peace-2005-ed-3-vols). For more recent examples of scholarly support for the above-mentioned 'rules', see: Winiarski, B. (1933) 'Principes généraux du droit fluvial international', *Collected Courses of the Hague Academy of International Law, The Hague Academy of International Law*, Vol. 45, p.6; Gleditsch, K. (1952) 'Rivers as international boundaries', *Nordisk Tidsskrift for International Relations* 22, pp. 15-32; Shalowitz, A. L. (1964) *Shore and Sea Boundaries*, Vol. 2, pp.374-75; and Prescott, J.R.V. and Triggs, G. (2008) *International Frontiers and Boundaries: Law, Politics and Geography,* The Hague: Martinus Nijhoff, pp. 215-19.

[21] For examples of scholars who are more sceptical of the existence of international law rules concerning the definition of boundaries in rivers see: Bouchez, L. J. (1963) 'The fixing of boundaries in international boundary rivers', *International and Comparative Law Quarterly* 12, pp. 789-817; Donaldson, J.W. (2011) 'Paradox of the Moving Boundary: Legal Heredity of River Accretion and Avulsion', *Water Alternatives* 4(2), pp. 155-70 (http://www.water-alternatives.org/index.php/allabs/137-a4-2-4/file); and Schroeter, F. (1992) 'Le Système de Délimitation dans les fleuves internationaux', *Annuaire Français de Droit International*, XXXVIII, pp. 948-82.

[22] AHG/Res. 16(I), Resolutions adopted by the First Ordinary Session of the Assembly of Heads of State and Government held in Cairo, 17-21 July 1964 (https://au.int/sites/default/files/decisions/9514-1964_ahg_res_1-24_i_e.pdf and https://au.int/sites/default/files/decisions/9514-1964_ahg_res_1-24_i_f.pdf).

However, respect for inherited boundaries does not prevent neighbouring States from concluding an agreement which provides a clearer delimitation of a vaguely-defined boundary, for example an agreement which changes the definition of the boundary from 'the river' to 'the thalweg of the river' or a list of coordinates defining the alignment of the boundary with greater geographic precision. Nor does the principle prevent an agreement to change the location of a boundary in a river from its alignment at the time of independence if that alignment is difficult to identify or if it does not meet the practical requirements of the two States. Examples of such a change might include:

(i) changing a boundary originally described as following the thalweg to the median line between the banks in a river that is dry for much of the year and/or where the river bed is so flat that the thalweg is almost impossible to identify; and
(ii) changing a boundary originally defined as following one of the banks to a line within the river channel, so that inhabitants of both banks enjoy access to the river.

Improving the quality of a boundary delimitation and/or adjusting the alignment of a boundary based on current realities and practical needs is not incompatible with the principle of respect for inherited boundaries – and many river boundaries in Africa are calling out for such clarification or adjustment. It is always useful to ask: what was the intention of the people drafting a treaty decades or even centuries ago? If an island has disappeared, or the river has dried out, or use of the river (e.g. for navigation, fishing or irrigation) has changed in the meantime, modifications may well be appropriate. Of course, any changes to an existing delimitation can only be made if both States agree to the changes.

3.9 Conclusions

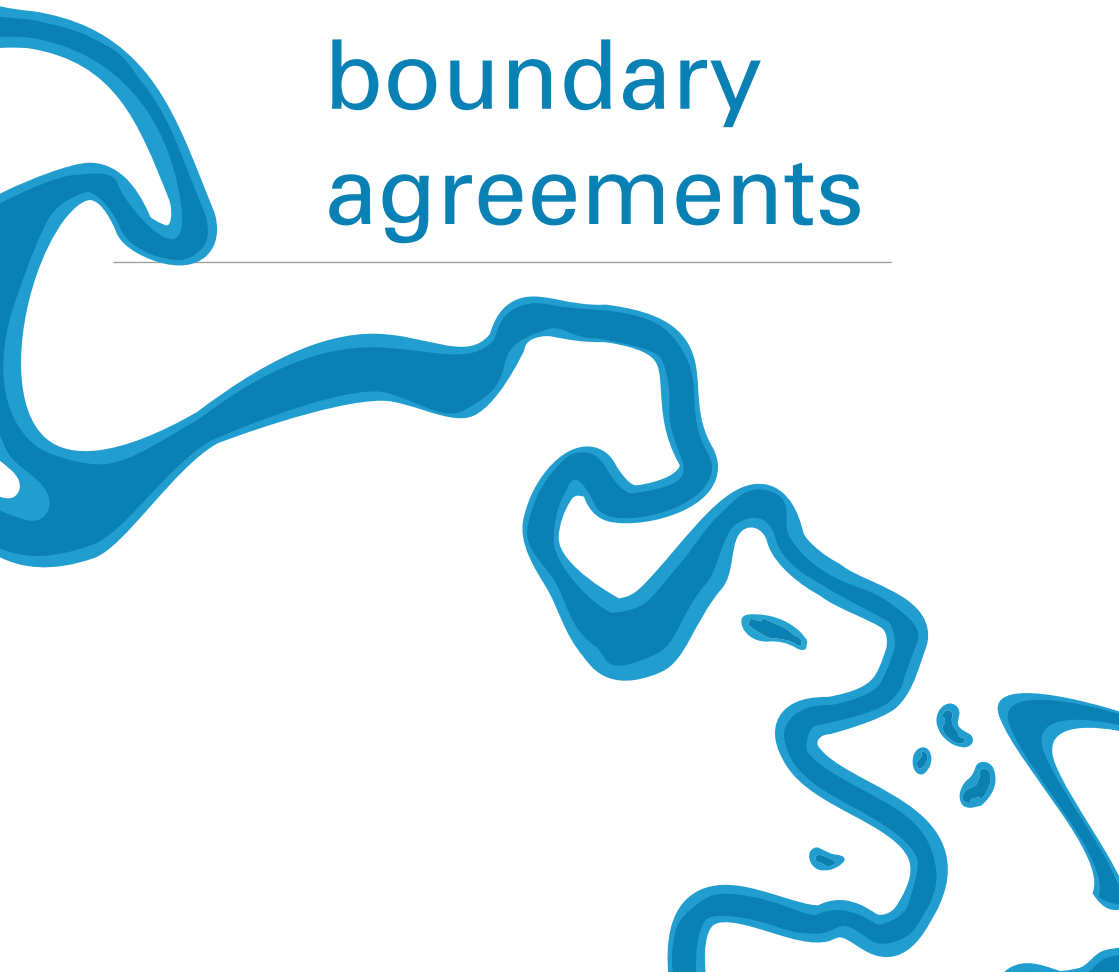
There are no international conventions concerning the delimitation or demarcation of river boundaries. Some scholars have argued that certain customary rules apply when the agreement defining the boundary is silent about the location of the boundary in a river and/or what happens to the boundary if the river channel moves, but other scholars have challenged those arguments. Perhaps more significantly, the International Court of Justice has not indicated the existence of any customary law on the definition of river boundaries, even though it could have done so on several occasions if it felt that such customary law existed.

From the above, the authors of this guide book draw two conclusions. First, States are free to define a boundary in a river in any way that best fits their needs. Second, if an existing delimitation fails to specify where

in the river the boundary is located, or fails to state what happens to the boundary if the river moves, there are no 'default' arrangements that apply automatically. In such situations, the boundary remains only loosely defined both spatially and temporally, and it is up to the neighbouring States to decide whether and how to clarify the boundary definition. In this context, a flexible interpretation of the African principle of respect for borders existing at the time of national independence is important. A significant number of African river boundaries are currently defined as simply 'the river', and only a few agreements address the consequences of changes in river channels over time. Most African river boundaries will therefore need further definition – and perhaps some adjustment – if neighbouring States wish to avoid uncertainty, minimise disagreement, and facilitate equitable use and effective management of their river boundaries. Issues that need to be considered in agreements defining (or redefining) river boundaries are discussed in the next chapter.

Chobe river.
Photo: benjamonio.
Image available at www.flickr.com/photos/benjamonio/7378949360.

4 Issues to be addressed in river boundary agreements



Existing agreements concerning river boundaries vary considerably in the level of detail they provide on the definition of the boundary and arrangements relating to the use and management of the river. Most agreements describe conceptually where in the river the boundary is located, although a significant number – especially in Africa – simply indicate that between defined locations the boundary 'follows the river'. Relatively few river boundaries currently have agreed arrangements concerning the consequences for the boundary in case of changes in the river course. Even fewer agreements address practical issues such as access to the river and the use of its water and other resources. Ideally, all agreements relating to river boundary delimitation would address at least the following questions:

- Where in the river is the boundary located?
- What happens to the boundary if the river channel changes?
- If there are islands in the river, who has sovereignty over the islands?
- What happens if new islands form in the river? What happens to islands if the boundary moves from one side of an island to the other? What happens if an island grows across the boundary, or merges with another island under the sovereignty of the other State, or merges with the opposite bank?

Other issues relating to river boundary definition and management which need to be considered and potentially addressed in a delimitation agreement – or perhaps in additional agreements – include:

- Should the boundary be demarcated? If so, what method(s) of demarcation should be used?
- Should residents of the two countries have access to the whole river regardless of the location of the boundary? If so, should access be restricted to certain people (e.g. people living within a certain distance of the river) and/or certain activities (e.g. navigation and fishing)?
- How should any regulations relating to the use of the river be enforced, and how should disputes relating to the use of the river be resolved?

Each of these questions is discussed in more detail in the following sections. It is important to bear in mind that the answer to each question may be different in different boundary rivers, and even in different sections of a single boundary river.

4.1 Where in the river is the boundary located?

If the existing definition of a river boundary is simply 'the river' or similar (e.g. the 'course of the river'), it will almost always be sensible to identify the boundary's location within the river channel more clearly. Even when a more precise definition already exists, it may be worth considering whether the existing location makes sense in the context of the physical and human geography of the river today. For example, if the boundary is defined as following the thalweg but the river has largely dried up and is no longer navigable, a median line between the banks might be easier to

identify and administer. Or if the boundary is defined as following one of the banks but there are people living on both banks who need access to the river, a boundary somewhere within the river channel might reduce the risk of tension between the populations on both banks. This section offers some reflections on the benefits and disadvantages of different boundary lines within rivers.

4.1.1 Thalweg

For physical geographers, the thalweg (a German word which literally means 'valley way') refers to the line of deepest water in a river channel. The International Court of Justice has noted that the word has also been taken to mean 'the most suitable channel for navigation' on the river or 'the median line of the main channel followed by boat men travel-

Figure 4.1 A trading pirogue alongside a ferry on the Congo river. Local navigators are likely to know the approximate alignment of the thalweg time based on experience and observation. Photo: Ollivier Girard/CIFOR.[24]

[24] Image available at flickr.com/photos/cifor/35854462866. Image reproduced under Creative Commons Attribution-NonCommercial-NoDerivs 2.0 Generic license (CC BY-NC-ND 2.0).

ling downstream'.[23] Since navigators want to avoid running aground, they tend to seek out the deepest channel, so in practice these three definitions refer to the same line – although it is not entirely helpful that there is no universally-accepted definition of the thalweg.

Even if the thalweg is not the legal 'default' line in navigable rivers (see chapter 3), the attraction of having the boundary follow the thalweg in a navigable river is clear: it provides both States with equal access to the main navigable channel, and ensures that neither State can prevent navigation along the river by vessels authorised by the other State.

Local navigators are likely to know the approximate location of the thalweg at any time based on experience and observation. From a practical perspective, therefore, a boundary defined simply as 'the thalweg, wherever it may be located' (possibly subject to provisions relating to changes to the thalweg as the result of avulsion) may be all that is needed to make the boundary fit for purpose.

If the governments feel that it is essential to identify the thalweg with geographical coordinates, a hydrographic survey may be necessary. Unless the geometry of the river channel is already known, that could be a very costly exercise. It is also likely that, sooner or later, those coordinates will no longer define the thalweg. If the boundary definition is accompanied by a 'freedom of navigation' provision, that fact would probably not create significant practical problems. However, without a guarantee of free navigation within the river, a boundary which no longer follows the thalweg could result in navigational difficulties, especially for commercial vessels with substantial drafts (see chapter 4.5 for further discussion of the benefits of maximising access to the river from both banks for navigation and other purposes).

One possible way of managing a 'fixed' boundary (i.e. a boundary defined with coordinates that do not move if the thalweg changes) in a navigable river would be to provide for a resurvey of the river every few years, with the boundary being relocated to the new thalweg in places where there

[23] *Case Concerning Kasikili/Sedudu Island (Botswana/Namibia)*, Judgment of 13 December 1999, paragraph 24.

has been a significant shift in the thalweg. Resurveys would likely be expensive, and it is easy to imagine finance ministries asking whether a proposed survey is essential when there are schools and hospitals that also need funding. Boundary negotiators should therefore consider carefully whether regular resurveys are really likely to take place before proposing them as a way to address the risk of a thalweg moving away from a boundary defined with coordinates. It would also be necessary to define what constitutes a significant shift in the thalweg.

4.1.2 Median line

In the United Nations Convention on the Law of the Sea, the median line between two coastlines is defined as a line 'every point of which is equidistant from the nearest points on the baselines from which the breadth of the territorial seas of each of the two States is measured'.[24] Adapted to rivers, the definition could be 'a line every point of which is equidistant from the nearest points on the banks of the river'. In nearly all circumstances, such a line will divide the area between the banks more or less equally. This has obvious attractions from the perspective of equity.

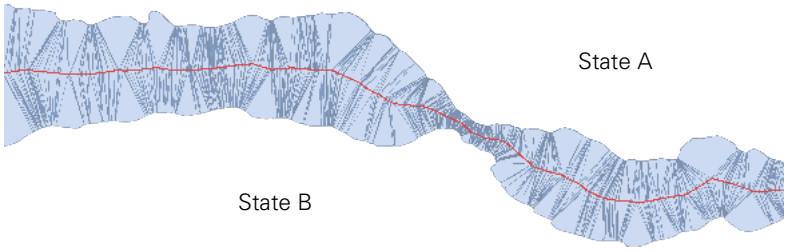


Figure 4.2 A schematic depiction of a median line showing the points on the two banks which 'control' each section of the median line.

[24] United Nations Convention on the Law of the Sea, Article 15.

If there is agreement on the configuration of the banks, a second attractive feature of a median line is that the line can be located easily using tools available in geographic information systems (GIS). Some rivers have clearly defined banks that can often be located using satellite imagery without the need for extensive field survey work. However, there are few rivers where the banks can be identified without difficulty along their entire length. In many rivers, reaching agreement on the alignment of the banks may prove so difficult that the median line turns out to be a very unattractive choice for a boundary (see the next section for further discussion on the definition and identification of river banks).

Once the banks have been defined, constructing the median line is a purely geometric exercise. Specialist GIS tools such as CARIS LOTS Limits and Boundaries[25] and Geocap Maritime Limits and Boundaries for ArcGIS[26] can generate in a few seconds a median line between two defined lines on a specified ellipsoid with great precision. Although these tools were designed for use in maritime boundary delimitation, they can also be used to identify the median line in a river. However, they are expensive to purchase, and training will likely be required before they can be used with confidence. Moreover, while geodetic calculations are important for coastlines which may be hundreds of kilometres apart, the difference between a geodetic and planimetric median line in a river channel is negligible. In this context, several free or low-cost GIS tools are worth considering. Examples include: the EqDistant Plugin for QGIS[27], the ET Geowizards Create Centerline Tool[28], the River Bathymetry Toolkit Centerline Tool[29], and the Polygon to Centerline tools for ArcGIS and QGIS.[30] It is recommended that advice is sought from GIS specialists on which option will best suit existing GIS expertise and infrastructure within the neighbouring governments.

[25] www.teledynecaris.com/en/products/lots-limits-and-boundaries.

[26] www.geocap.no/article/martime-limits-and-boundaries-for-arcgis.

[27] https://ivanbusthomi.github.io/plugins/eqdistant.

[28] www.ian-ko.com/ETGeoWizards.html.

[29] https://sites.google.com/a/essa.com/rbt/bankfull-centerline-tools/centerline-tool.

[30] See https://arcgis.com/home/item.html?id=bc642731870740aabf48134f90aa6165 for ArcGIS; https://pro.arcgis.com/en/pro-app/tool-reference/topographic-production/polygon-to-centerline.htm for ArcGIS Pro; and https://gis.stackexchange.com/questions/269238/create-a-center-line-between-2-polyline-qgis for QGIS.

The reason why median lines have often been used as boundaries primarily in non-navigable rivers is that the median line does not always coincide with the thalweg. Therefore, in navigable rivers with a boundary following the median line, it is likely that the thalweg will be entirely within one State's territory at certain points and entirely within the other State's territory at other points, creating potential difficulties regarding navigation. However, where a 'freedom of navigation' regime exists, there is no reason why the median line should not be considered as an alternative to the thalweg as a boundary in a navigable river.

Since median lines are defined with reference to the banks, any change in the configuration of either bank will produce a change in the alignment of the median line. As with thalweg boundaries, States choosing a median line boundary will therefore need to accept either that the boundary will move over time or, if the boundary is fixed with coordinates, that the boundary will only be a true median line at the time of delimitation. In highly dynamic rivers, it is quite possible that the median line will have moved between the time it was constructed and the time that the boundary is formally agreed.

4.1.3 Bank

River banks are not common choices as international boundaries for obvious reasons: a bank boundary means that the population of one of the riparian States enjoys all the benefits of the river, while the inhabitants of the other State – even those who live right on the river bank – have no automatic right to access the river or use its water and other resources. Such rights can, of course, be granted by agreement or they may exist *de facto* as a result of local custom. This appears to be the case with most bank boundaries from the colonial era inherited by African States. However, the general absence of tension along existing bank boundaries does not necessarily mean that a bank is a good option for a boundary.

States who wish to use a bank or the median line between the banks as a boundary will need to agree on a definition of a bank. Geographers often define the banks as the sides of the river channel between which the flow is confined. In reality those are usually zones rather than clearly identifiable lines, and sometimes the zones can be quite extensive. Where there is a relatively clean break between channel and floodplain, the concept of bankfull discharge can help to identify a line representing the tops of the banks (as discussed in chapter 2.2, bankfull position is the location on the banks where the river can flow out onto the floodplain; in geometric terms it is where the channel's width/depth ratio is at a minimum). In forested areas the limits of vegetation beside a river will also likely provide a reasonable approximation of the bank. However, even in the most helpful circumstances, defining a single line to represent the bank is likely to be as much art as science. In almost all cases, considerable flexibility and willingness to compromise will be needed when governments negotiate the alignment of river banks.

An arguable benefit of choosing a bank as a boundary is that it is easier to identify the alignment of one bank than the two banks required for the construction of a median line. In sparsely populated areas where access to the river channel is not a major issue, neighbouring States might therefore consider agreeing that the boundary should follow the left bank of the river for half of length of the boundary and the right bank for the other half.[31] Such an approach would still give each State an equal share of the river while minimising the technical challenges associated with defining the boundary. However, the task of defining two banks is unlikely to be substantially more demanding than defining just one bank, so there probably needs to be a better rationale for choosing bank boundaries than a modest time- and cost-saving for surveyors and cartographers.

In most circumstances, bank boundaries are probably best avoided if a choice is available. States which have inherited bank boundaries should consider whether conditions exist which would make moving the boundary into the river channel a sensible option. If the inhabitants of the bank along which the boundary runs can use the river to their satisfaction, there is arguably no need to change the *status quo*. However, if the existence of a bank boundary creates anxiety or resentment among those inhabitants, it is worth exploring an alternative alignment for the boundary which would allow for equal access to the river and reduce the risk of boundary-related conflict.

4.1.4 Main channel

A significant number of agreements defining boundaries in rivers indicate that the boundary follows the main channel of the river or is located in the middle of the main channel. In rivers which are used for navigation on a regular basis, the main channel is likely to be obvious: it will be the channel used most frequently by boats. However, in rivers which see little or

[31] The left and right banks of a river are defined in relation to the direction of river flow, with the observer facing downstream. Referring to banks with compass directions (north, south, east and west) may make sense along short stretches of a river, but in meandering rivers a bank that is described as the 'north bank' at one point is likely to be the east, west or even south bank at other points. Reference to the left and right banks may see rather unscientific, but anyone tasked with describing the geography of a river will quickly appreciate the advantages of using those terms.

no traffic, the main channel is not always easy to identify, especially in braided or anastomosing rivers.

The concept of the main channel was examined at length by the International Court of Justice in the *Kasikili/Sedudu Island (Botswana/Namibia)* case in the late 1990s, but no clear method for determining the main channel in any given river emerged. The Court first observed that:

> *… it cannot rely on one single criterion in order to identify the main channel of the Chobe around Kasikili/Sedudu Island, because the natural features of a river may vary markedly along its course and from one case to another. The scientific works which define the concept of 'main channel' frequently refer to various criteria: thus, in the Dictionnaire français d'hydrologie de surface avec* ***équivalents*** *en anglais, espagnol, allemand (Masson, 1986), the 'main channel' is 'the widest, deepest channel, in particular the one which carries the greatest flow of water' (p. 66); according to the Water and Wastewater Control Engineering Glossary (Joint Editorial Board Representing the American Public Health Association, American Society of Civil Engineers, American Water Works Association and Water Pollution Control Federation, 1969), the 'main channel' is 'the middle, deepest or most navigable channel' (p. 197). Similarly, in the Rio Palena Arbitration, the arbitral tribunal appointed by the Queen of England applied several criteria in determining the major channel of a boundary river.*[32]

[32] *Case Concerning Kasikili/Sedudu Island (Botswana/Namibia)*, Judgment, 1999, paragraph 30.

The Court then examined the arguments of Botswana and Namibia relating to the channels in the Chobe river around Kasikili/Sedudu island in terms of their depth, width, flow (i.e. the volume of water carried), bed profile configuration and navigability. In that particular case the Court concluded:

(i) that the determination of the main channel should be made according to the low water baseline and not the flood line[33]; and
(ii) that since 'the navigability of a watercourse is the combined result of its depth, its width and the volume of water it carries, taking account of natural obstacles such as waterfalls, rapids, shallow points, etc., along its course', the main channel in that part of the Chobe was the channel which offered 'more favourable conditions for navigation'.[34]

The ICJ's ruling is only binding on Botswana and Namibia with respect to the boundary in the vicinity of Kasikili/Sedudu Island, and other States are not required to adopt the Court's approach in their river boundaries. Even if they were, identifying the channel which provides the more favourable conditions for navigation remains a somewhat subjective exercise. However, the ICJ's decision that the main channel should be determined at the low water rather than in flood conditions is probably appropriate in most circumstances.

Ideally, identification of the main channel should involve at least one physical inspection of the relevant section(s) of the boundary river during the season of lowest flow. A visit during the season of highest flow may also be useful for comparative purposes and may result in a different perception of the nature of the river and its channels. However, many boundary rivers are both long and located in wild or remote areas, making field inspections difficult and sometimes impossible. In such circumstances, satellite imagery can help inform understanding of river flow patterns. There are a growing number of sources of freely available high-resolution imagery, several of which offer views of a given area at different points in time.

[33] *Idem*, paragraph 37.
[34] *Idem*, paragraph 40.

Google Earth[35] is probably the best-known product offering such imagery, and it remains a useful and very-user-friendly tool. However, for river boundary analysis the most useful resource is probably the Global Surface Water Explorer (GSWE) developed by the European Commission's Joint Research Centre.[36] The GSWE provides access to the same imagery as is available in Google Earth, but it also includes a dataset which maps the location and temporal distribution of water surfaces across the planet over the past 35 years and provides statistics on the extent and change of those water surfaces. A series of filters offer views of water occurrence, seasonality and transitions, making it possible to distinguish (for example) channels in which water is permanently present from channels which dry up seasonally or at least occasionally. The dataset was generated using Landsat imagery with a resolution of 30 metres per pixel, which means that some narrow boundary rivers returned little or even no data; but for larger rivers the dataset can be very helpful in identifying candidates for the title of 'main channel'.

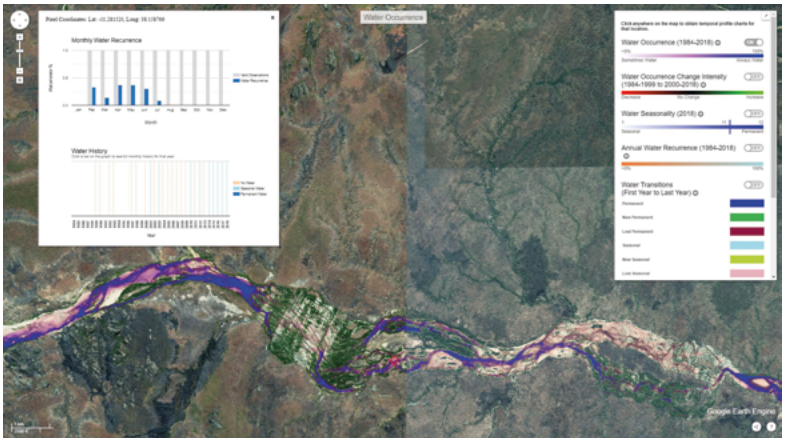


Figure 4.3 A screenshot from the Global Surface Water Explorer showing a complex section of the Rovuma river which forms the boundary between Mozambique and Tanzania. The dark blue shading indicates where water has been present in all images in the 35 year dataset. The graphs on the left provide more detailed information on the presence and recurrence of water at the location with the red marker.

[35] www.google.com/earth. ESRI's ArcGIS Earth (www.esri.com/en-us/arcgis/products/arcgis-earth) is a similar product to Google Earth with different imagery in many areas. Microsoft's Bing Maps (www.bing.com/maps) also offer some very good-quality imagery for much of the world in its Aerial mode.

[36] https://global-surface-water.appspot.com.

4.2 Islands

Most rivers which are significant enough to be chosen as international boundaries are likely to have at least one island in the river channel through which the boundary runs. As discussed in chapter 2.2, braided and anastomosing rivers may contain dozens or even hundreds of islands, and even meandering rivers can have islands (see Figure 2.10). How to determine sovereignty over islands is therefore a question that most States with river boundaries are likely to have to address.

4.2.1 Definition of an island

Before deciding on a methodology for allocating sovereignty over islands in a boundary river, it is sensible to count how many islands there are and note where they are located. This requires an agreement on what constitutes an island. Insular features vary greatly in their size, composition (varying combinations of mud, sand and rock) and the amount and type of vegetation growing on them. Some 'islands' are exposed during the dry season but are covered by water during periods of heavy water flow. Are all insular features true islands which should be considered land territory which just happens to be located in a river, or is it more appropriate to treat some insular features simply as raised elements of the river bed which do not require a formal allocation of sovereignty?

There is no international agreement concerning the definition of an island in a river. The definition of an island in the United Nations Convention on the Law of the Sea ('a naturally formed area of land, surrounded by water, which is above water at high tide'[37]) could potentially be adopted by States with river boundaries, with 'high tide' being replaced by an agreed river water level. It might also be useful to address the size and/or physical composition of the island in the definition, perhaps using the kind of

[37] United Nations Convention on the Law of the Sea, 1982, Article 121(1).

language employed in the agreement defining the boundary between Mozambique and Tanzania in the Rovuma river:

> *For the purpose of this agreement there shall be considered as islands only those which emerge when the river is in full flood and which contain land vegetation and rock or firm soil and are not shifting sandbanks.*[38]

Other definitions are certainly possible, but the notion of permanence is probably a useful basis for any definition of an island. Whatever definition is used, it should be agreed before trying to settle the question of which State has sovereignty over which islands in the vicinity of a river boundary.

[38] Exchange of Notes constituting an Agreement between the United Kingdom and Portugal regarding the Boundary between Tanganyika Territory and Mozambique, May 11, 1936-December 28, 1937, Article 1.

4.2.2 Island sovereignty and boundary delimitation

Where existing agreements are silent on island sovereignty, three broad approaches are possible:

(i) define the boundary first, with sovereignty over islands being determined according to which side of the boundary the islands lie;

(ii) define sovereignty over islands first and then define a boundary guided by the allocation of islands; or

(iii) employ a combination of approaches (i) and (ii), with most islands being allocated with reference to the boundary, but certain islands being treated as exceptional cases.

Figure 4.4 Part of the Luangwa river boundary between Mozambique and Zambia. Are the insular features in the river true islands or simply exposed parts of the river bed? Photo: © Rosalda Tavete.

As with almost all aspects of river boundary definition, the most appropriate approach depends on the physical and human geography of the river, and in some cases the administrative history of the river as well.

i. Boundary determines island sovereignty

When islands in a boundary river have no special significance for either State, the most common approach is to allocate sovereignty over each island according to its position in relation to the boundary, e.g. if the boundary follows the thalweg and an island lies on State A's side of the thalweg, the island also belongs to State A. This approach obviously requires an understanding of the general alignment of the thalweg (or whatever line is chosen for the boundary). It can also result in significant differences in the number of islands and/or the total area of island territory allocated to each party.

The 'boundary first' approach may not be ideal for a boundary which follows the median line between the banks, as the median line can run across islands. If that happens, the two States would have to make additional decisions: they could perhaps agree to share sovereignty over the island; or divide the island along the median line; or adopt another method for determining sovereignty – for example, allocating the island to whichever State would have the larger area over the island if it was divided along the median line. The latter option is perhaps the least complicated: dividing the island would raise questions about whether physical demarcation of the boundary on the island is required – and sharing sovereignty would probably require further agreements regarding administrative arrangements. There are approximately seventy river islands around the world which are divided by boundaries although, as far as the authors are aware, none of the islands is in Africa.[39] Only one example of shared sovereignty over an island in a boundary river has been found: under an agreement dating back to 1659, the tiny and uninhabited Pheasant Island on the Bidasoa river in the Basque Country of northern Spain and south-

[39] See https://en.wikipedia.org/wiki/List_of_divided_islands for a list of divided islands. 70% of the islands listed are on the Canada-USA boundary.

ern France is administered by France for six months of each year and by Spain for the other six.

ii. Island sovereignty determines boundary

A less common but also potentially less problematic approach to dealing with island sovereignty is to agree on a methodology for allocating islands first, and then delimit the boundary taking island sovereignty into account.

The Mozambique-Tanzania boundary provides an example of such an approach, with all islands in the Rovuma river upstream of its confluence with the Domoni river belonging to Tanzania and all islands downstream of the confluence belonging to Portugal. In principle, the boundary in the Rovuma is the thalweg of the river. However,

> *In places in the river where the channel between the islands and the bank belonging to the other territory does not contain the thalweg of the river, the boundary shall follow the thalweg of that subsidiary channel until it meets the thalweg of the Rovuma river.*[40]

This definition means that it is not essential to know which channel around an island contains the thalweg of the Rovuma in order to determine the general alignment of the boundary, which is useful in a river with complex hydrology and hundreds of islands. An upstream/downstream approach to island sovereignty also allows the two States to identify a point for dividing sovereignty which allocates the number of islands (or the total land area of islands) equally between them.

[40] Exchange of Notes constituting an Agreement between the United Kingdom and Portugal regarding the Boundary between Tanganyika Territory and Mozambique, May 11, 1936-December 28, 1937, Article 2.

If the boundary is defined by the median line, allocating islands first allows the islands to be incorporated into the definition of the relevant banks, with the result that the boundary never runs across an island.

iii. Sovereignty over exceptional islands

There are a number of scenarios in which it may be sensible to determine sovereignty over certain islands in a boundary river independently, even when sovereignty over most islands is determined by the kind of formula discussed above. Examples include:

- islands which are inhabited;
- islands which are uninhabited but which are cultivated by local farmers;
- islands which have a special religious or cultural significance for local people;
- islands which have been subject to particular administrative arrangements.

In any of these scenarios, if there is evidence that an island has greater value to one State than the other, it probably makes sense to allocate sovereignty over the island to that State, even if it runs contrary to the general formula for allocating islands. If the island is located on the 'wrong' side of a boundary which is defined by geographical criteria, it will be necessary to decide whether the boundary should be diverted to prevent the island from becoming 'enclaved' within river waters that are under the sovereignty of the neighbouring State. In principle it seems sensible to avoid enclaving of territory, but there are plenty of examples around the world of enclaves which function without any significant practical difficulties – and in most rivers it is difficult to imagine many problems arising in relation to an island which can only be accessed by crossing a short stretch of the river which is under the sovereignty of the neighbouring State. However, every case will be unique, and the two governments will have to weigh up issues such as how the island is used, how far it is from the sovereign State's bank, and extent to which there is freedom of movement within the river.

4.3 Changes in the river

Some river channels are more stable than others (see chapter 2) but all rivers change over time. Even a river whose channel is constrained by bedrock (or concrete) will eventually erode the base to a degree which could lead to a change in the alignment of the channel. Earthquakes, landslides and construction can also lead to unexpected changes in seemingly stable channels. In alluvial channels gradual change through erosion and accretion is inevitable, and sudden (and often significant) change through avulsion is possible in many areas. Since there are no conventional or customary legal rules concerning the consequences for boundaries of changes in a river channel (see chapter 3), all boundary agreements should address this issue in some form.

4.3.1 Accretion and avulsion

While there may be no legal obligation to agree that a boundary in a river changes with accretion but not with avulsion, in many scenarios such a provision makes a great deal of sense. Allowing the boundary to move with the river under normal conditions maximises access to the river on both sides and avoids the creation of pockets of territory belonging to one or both States on the 'wrong' side of the river – which is the likely consequence of creating a fixed boundary that does not move with the river (Figure 4.5).

Figure 4.5 A section of the Myanmar-Thailand boundary along the Ruak river. The boundary has been demarcated along the course of the Ruak as it was mapped in the 1940s, and the boundary does not move with the river. As a result, numerous pockets of territory are now located on the 'wrong' side of the river and are difficult for local farmers to access. The field patterns in the image suggest that the practical consequence is that farmers continue to treat the river as the boundary, with farmers from Myanmar cultivating land that is officially part of Thailand and vice versa. Image: Google, CNES/Airbus.

From a legal perspective, the existence of such pockets is not necessarily problematic. On a practical level, however, they can create difficulties. People living in the pockets will only be able to access the rest of their country's territory either by crossing the river or by passing through the territory of the neighbouring State. The same applies to government authorities.[41] If the pockets are uninhabited, there is a risk that sooner or later they will be abandoned by the local population if the effort required to

[41] In 2018 Belgium and The Netherlands decided to exchange around 20 hectares of land in the Meuse river because of difficulties in administering areas which had ended up on the 'wrong' side of the international boundary due to shifts in the course of the river. According to a news report: 'One uninhabited peninsula had proved almost impossible for the Belgians to police. Because they required special permission to travel through Dutch territory, they were forced to approach it by boat. The lawless enclave was reportedly popular for illegal raves, drug deals and prostitution. Four years ago, a headless body was discovered on the peninsula and reported to Dutch police. The Dutch were unable to investigate the crime on Belgian territory, while the Belgian police were forced to ferry prosecutors, labs and investigators to the peninsula. Making matters even more complicated, the peninsula had no docking area for boats.' (www.telegraph.co.uk/news/2018/01/04/belgium-netherlands-swap-territory-move-border-headless-body/).

access them exceeds the benefit that can be derived from continuing to make use of them. The practical challenges are rarely insurmountable, but they may require investment in infrastructure and/or an additional agreement between the two governments concerning access or transit rights. The likelihood of such problems arising will vary with factors such as: the population and land use on the two banks; the width and depth of the river over the course of the year; and how easy it is to pass through the territory of the neighbouring State. Each case should therefore be considered in context, but the potential disadvantages of the boundary not moving with the river under normal conditions should not be underestimated.

Legally, there is nothing to prevent two States from agreeing that a boundary should move with the river in the case of avulsion as well as accretion. However, the scale of an avulsion is unpredictable, and the consequence could be the loss of a significant area of State territory. An unconditional agreement that the boundary should move with the river following an avulsion is therefore probably not advisable. A more sensible alternative would be to agree a threshold – in terms of either geographical area or population affected – which will determine whether the boundary moves with the river following an avulsion or not.

An interesting example of this approach can be found in the 1970 boundary agreement between Mexico and the USA, which specified that the boundary would move with the river in the case of an avulsion affecting an area of less than 250 hectares and a population of less than 100. However, in such cases the State which would lose territory as a result of the boundary change was given the option of unilaterally restoring the river to its previous channel within three years, thereby returning the boundary to its previous alignment. If the avulsion affected an area of more than 250 hectares and with a population of more than 100, the boundary would not move and the two States agreed to restore the river to its old bed as soon as possible.[42]

It is unlikely that such an approach would make sense in all circumstances, even if the States involved have the financial and technical resources to make restoring a river to its previous channel an option. For most

[42] www.ibwc.gov/Files/1970_Treaty.pdf.

States, agreeing that the boundary will not move in the event of any avulsion is probably a more practical option. Nevertheless, the Mexico-USA agreement illustrates the kind of creative solution that States might consider under the right circumstances.

4.3.2 Changes involving islands

In dynamic rivers, particularly in braided rivers, islands can appear, disappear, grow, shrink and move on a regular basis. States with boundaries in such rivers should consider including provisions relating to river islands along the lines of the sophisticated provisions agreed by Brazil and the United Kingdom (on behalf of British Guiana) in 1932:

> *(iii) The position of the thalweg cannot be relied upon to remain constant owing to the natural action of the water, e.g., the gradual deposit of alluvium silting up and perhaps even closing channels. The question of the change of sovereignty of islands on account of the movement of the thalweg through such causes shall be determined as follows:*
>
> *(a) Where, owing to the gradual movement of the thalweg, an island situated at the time of demarcation on one side of it is found, at any subsequent time, to be situated on the opposite side of the thalweg and still remains an island, its sovereignty shall not change, despite the change in the position of the thalweg.*
>
> *(b) Where, owing to the gradual movement of the thalweg or to the deposit of alluvium or to the other gradual and natural causes, an island situated at the time of demarcation in the territory of one State becomes joined to the territory of the other State its sovereignty shall change.*

(c) Where, in virtue of the gradual and natural action of the river, two islands of different sovereignty unite and form one island, the sovereignty of the island resulting from that union shall be determined by its position with relation to the thalweg at that time.

(d) An island shall-be deemed to be joined to another island or to the mainland when the level of the bed separating the two shall have risen to a height greater than that of the water at other than flood periods in that part of the river.

(e) Where, owing to the deposit of alluvium, or other gradual and natural causes, a new island is formed attaining a height greater than that of the water at other than flood periods in that part of the river, where previously no land existed, it shall belong to that State on whose side of the thalweg it may be situated, wherever the thalweg may be at the time of the appearance of the island.

(f) Each State shall have the right both to protect its own banks and islands from the gradual and natural action of the river and also to effect works in its own territory to prevent any local deviation of the current of the main stream, or of any branch of the river, from its course at the time, provided in both cases that such works do not themselves cause any deviation elsewhere. [43]

Whatever the exact wording that States adopt, a good treaty will anticipate the impact on islands of future changes in the river and will provide agreed solutions for such cases.

[43] Exchange of notes between the Brazilian government and His Majesty's government in the United Kingdom constituting an agreement for the delimitation of the riverain areas on the boundary between Brazil and British Guiana, London, October 27th and November 1st, 1932; https://treaties.un.org/doc/Publication/UNTS/LON/Volume%20177/v177.pdf, pp. 128-130.

4.4 Demarcation

One reason why rivers were a popular choice as boundaries during the colonial era was that they were perceived as requiring little or no physical marking on the ground, thereby saving the colonial governments money. In his famous lectures on boundaries at Oxford University in 1907, the former Viceroy of India and future British minister of foreign affairs Lord Curzon suggested that: 'The position of the river is unmistakable, no survey is required to identify or describe it ….'[44] Another British diplomat, Edward Goschen, noted in correspondence on boundaries with his German counterpart in 1908 that: 'The selection of natural features such as streams and rivers has many advantages, not the least of which is that far fewer boundary pillars are required.'[45]

The view that a river is an 'unmistakeable' linear feature of the landscape may be true for many rivers in northern Europe, but it is certainly not always the case with rivers in tropical and sub-tropical regions. Is it reasonable to expect borderland populations simply to understand that 'the river is the boundary', or are there circumstances in which demarcation of a river boundary is appropriate?

In most river boundary settings, it is likely that traditional demarcation – with monuments erected on the boundary line – will make little sense. This is especially true when it has been agreed that the boundary will move with the river, as trying to keep the monuments on the actual boundary would require almost constant effort. Even when a boundary in a river has been fixed, there are numerous practical issues associated with demarcation. In any channel where water flows it is likely that monuments will be washed away sooner or later, even if it is technically possible to construct them in the first place. In rivers used for navigation, monuments attached to the river bed would be navigation hazards, and even floating buoys marking a thalweg boundary are likely to be irritating to navigators. The only setting where traditional demarcation might be practical for a

[44] Curzon, G.N. (1907) *Frontiers, Oxfords: Clarendon Press;* www.dur.ac.uk/resources/ibru/resources/links/curzon.pdf (digitised text); https://archive.org/details/frontiers00curz (scanned publication).

[45] Letter 2 Dec 1908, W.E. Goschen to von Schoen, UK National Archives FO 403/403B.

boundary in a river channel is one where the river has dried up completely. Demarcation might also be considered for a boundary located on the bank of a river but, in any river that is prone to flooding, monuments on the very edge of the river channel will be vulnerable to erosion.

An alternative to placing monuments along the actual boundary is to erect 'witness markers' on the river banks (possibly set back from the very edge of the channel to reduce the risk of being eroded away), with distance and direction to the boundary marked on them, or at an equal distance from the boundary on both sides of the river (see footnote 19 in chapter 3.6 for an example of the use of witness markers at river confluences). Such markers can be useful to boundary commissioners working in the field, for example in terms of monitoring the extent to which the river channel has moved in relation to a fixed median line boundary. They can also serve to remind local people that the river is an international boundary, although signs at the most frequently used access points to the river (with text in local languages as well as official languages) may be more effective in that respect.

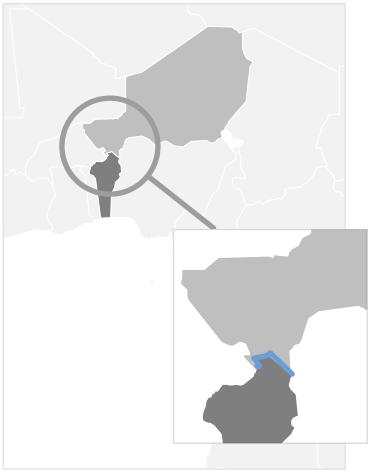
One setting in which demarcation is potentially very helpful is when the boundary in a river channel has been fixed at a certain point in time and the channel has subsequently moved away from the boundary so that one or both States have pockets of territory on the 'wrong' side of the river, as discussed in section 4.3. If those pockets are not clearly identified on the ground, considerable confusion can result, potentially leading to disputes between inhabitants of the two banks and even local administrations.

Beyond that one rather rare scenario, it is hard to think of circumstances in which demarcation of a river boundary is essential. Ensuring that the people who use or need to cross the river understand the nature of the boundary (and any limitations that it creates in terms of access to and use of the river) is certainly essential. However, in most cases that understanding is more likely to be achieved through an effective communication strategy than by simply erecting pillars. Markers such as a flag of the country or sole beacons that indicate the 'nationality' of an island, can be misinterpreted as boundary markers, so sensitisation of the local population and authorities is vital in any case.

It is usually helpful to discuss approaches to demarcation alongside the question of delimitation, and demarcation can be addressed in the same agreement as delimitation if the parties wish to do so. However, it is common for demarcation to be the subject of an additional agreement or agreements subsequent to delimitation, especially if significant survey work is required in preparation for demarcation. If future demarcation remains a possibility, it may be worth considering a clause in a delimitation agreement indicating that either government can propose further negotiations concerning demarcation. Even if no demarcation is anticipated along a river boundary at the time of delimitation, it is probably sensible not to rule out the possibility of future demarcation altogether.

4.4.1 Benin and Niger river boundary delimitation following the ICJ Ruling

The border between Benin and Niger stretches on 285 km along the respective sections of Niger River and Mékrou River.



Frequent clashes between the two countries' border populations, including a fatal incident in 1963, culminated in a border dispute over the island of Lété. Despite the establishment of two Mixed Commissions (1961 and 1963) and intense diplomatic negotiations to reach a final settlement (Dakar 1964 and Yamoussoukro 1965), the dispute reignited in 1993. In a bid to resolve the dispute the two States signed on 8 April 1994 in Niamey (Niger), an agreement to establish a joint commission to delimit their common border.

On 3 May 2002, Benin and Niger, via an agreement to refer the case to the International Court of Justice (ICJ) signed on 15 June 2001 in Cotonou (Benin), entered into force on 11 April 2002, seized the Court to find a peaceful solution to their boundary dispute.

On 12 July 2005, the ICJ delivered its judgment, delimiting the border between the Republic of Benin and the Republic of Niger as follows:

- In the sector of the Niger River, the boundary follows the line of the deepest soundings of the main navigable channel, i.e. the thalweg;
- On the Mékrou River, the median line fixes the boundary.

The Niger River is considered navigable which explains the choice of the thalweg to delimit whereas the Mékrou River is non-navigable hence the median line was chosen as the delimitation method.

The Joint Technical Commission made use of several sources of data and methods to implement the Judgment. The thalweg was drawn from existing bathymetric sounding data (NEDECO Report) approved by the ICJ. The coordinates setting the thalweg had been acquired in the Clarke 1880 coordinate system. The transformation parameters were established to convert the Clarke 1880 coordinates into the WGS84 system. This transformation has been performed with a combination of long observations on astronomical pillars close to the area, old topographic maps, high-resolution satellite images, and with the software Circé and Cooriste[46] of *'Institut national de l'information géographique et forestière'*. This process enabled the projection of the coordinates of the thalweg line on spatial-maps produced for this purpose in response to the wishes of the two States to limit themselves only to the mapping of the boundary line (no construction of physical boundary stones).

The technical team relied on satellite images and direct measurements (GNSS) especially in canopied areas to establish the median line of the Mékrou River. These two complementary sources of data (direct measurements and satellite images) were used to locate the banks on both sides of the river to deduce the position of the median line through algorithms using Geographic Information Systems Software (in particular ArcGIS).

The entire border was mapped out on eleven sheets at the scale of 1:25,000. The technical work, data processing, and field measurements

[46] Cooriste is an inhouse software designed by 'Institut national de l'information géographique et forestière'.

revealed a total boundary span of 285 km instead of the previously estimated 266 km. This 7% increase can be explained by the accuracy of the measurements which considered all the details of the sinuosity of the two rivers.

Following the delimitation of the river border, structures responsible for the security, surveillance, and security of movements and activities on the Niger River, namely the gendarmerie brigade of the Niger river and the Beninese navy benefited from a joint training on the new maps showing the border between the two countries. This training is part of the coordination and conduct of joint patrols between these two security forces. Besides, the assembly of border communities of the three countries (including those of neighboring Nigeria), who are in charge of the socio-economic development of the area, have defined an area of cross-border cooperation known as the Dendi-Ganda Cooperation Area. Lastly, the delimitation of the border, in particular on the Mékrou River, will facilitate concerted management of the conservation of the fauna and flora of Parc W straddling Benin, Burkina, and Niger. All of which will ultimately contribute to conflict prevention and the stabilization of this border area.

4.5 Access to and use of boundary rivers

For some States, questions of access to and use of boundary rivers may be covered by international agreements and regimes as discussed in chapter 5. Other neighbouring States may already have bilateral agreements relating to border management and cross-border cooperation that apply to their river boundaries as well as their overland boundaries. Others may believe that while there are management-related issues that still need to be agreed regarding a river boundary, discussion of those issues should be separate from questions relating to the definition of the boundary. If none of the above situations apply, States involved in river boundary negotiations should consider whether it would be helpful to include management-related provisions in any agreement that they conclude.

Broadly speaking, the more people who live along the banks of a boundary river, the greater the need for at least some management-related rules

to be established. However, that is a broad generalisation and many other factors can affect the level of regulation that is required. Such factors include: the size, resource potential and navigability of the river; the degree to which the inhabitants of the two banks rely on the river for their livelihoods; and the strength of ties between the inhabitants of the two banks.

4.5.1 The desirability of freedom of navigation and sharing river resources

Assuming generally good relations between the neighbouring States and the people living along the banks, there is much to be said for including a provision guaranteeing freedom of navigation anywhere within the boundary river for citizens of both States (or even for anyone who wishes to travel along the river). If the river can support unregulated fishing, irrigation, extraction of sand and/or agriculture on islands in the river, freedom to undertake such activities anywhere in the river could be guaranteed for local people as well. The practical effect of such provisions would be to turn the river into a shared resource zone in which the precise location of the boundary is irrelevant on a day to day basis. In such a context, having a boundary that moves as the river channel changes would be unlikely to create administrative difficulties for either State.

States should, of course, think carefully before granting such broad freedoms. As always, the devil is in the detail, and it is easy to think of ways in which the freedoms granted could be abused and cross-border relationships could sour. What happens, for example, if an entrepreneur who lives far from the boundary buys a property on one of the banks and starts a commercial fishing venture that takes 90% of the fish from the river, leaving local fisherman with no livelihoods? Who decides how much water can be taken for irrigation on each bank if the water level in the river drops significantly? Who settles a dispute between two farmers from opposite banks who want to farm the same part of an island in the middle of the river? The neighbouring States need to consider whether such issues can be addressed by existing laws and dispute resolution mechanisms, at least to the extent that the potential benefits of sharing the river for practical purposes outweigh the risks. If the answer is ‘no’ or even ‘maybe’, it would probably be wise not to provide for such freedoms in a permanent

boundary agreement. If the answer is 'maybe', it may be better to offer the freedoms on a trial basis through a separate agreement with a limited duration before making a permanent commitment. Both in the assessment of potential disputes as well as their resolution, the potential role of local administrations should not be ignored. Local officials know the people who live along the river and their challenges best, and they are likely to be the first to intervene and solve problems. A treaty that is drafted solely by central governments in their capitals ignores a vital asset in the long-term management of the river.

Whether issues of access to and use of a boundary river are addressed alongside the definition of the boundary or elsewhere, they need to be addressed. Even the most precisely defined boundary will be of limited value if the lives of the people who live along it are miserable. Many people who live along a boundary river in Africa are likely to depend heavily on the river as a source of food, water and income. Wherever possible, States should work to develop administrative arrangements which ensure that the presence of a boundary in a river is not an obstacle to their needs.

4.6 Dispute resolution

No matter how carefully drafted a boundary agreement may be, the possibility of disagreement at some point concerning the interpretation or application of the agreement cannot be ruled out. Any such disagreement should obviously be settled by peaceful means, as emphasised in the charters of the United Nations and the Organization of African Unity and the Constitutive Act of the African Union. Negotiation, mediation, conciliation and arbitration are listed as possible means of international dispute resolution in the OAU charter[47], and the UN charter adds judicial settlement, resort to regional agencies or arrangements, and other peaceful means of the States' own choice to the list.[48]

[47] OAU Charter, Article III.

[48] UN Charter, Article 33.

Given the universally accepted framework for international dispute resolution, the absence of specific dispute resolution provisions in an agreement relating to a river boundary should not necessarily be a cause for concern. Many States prefer to keep their options open, especially since it is impossible to anticipate the nature of every disagreement that may arise. Nevertheless, States which are in the process of drafting a new or revised boundary agreement may wish to consider whether they wish to specify particular dispute resolution mechanisms or procedures which are appropriate in the context of the boundary agreement and the relationship between the States more generally.

For example, it may be desirable to specify that binding arbitration or adjudication of a dispute can only be considered after the two States have attempted to settle the dispute through mediation and/or conciliation. Or perhaps the States might wish to specify that a dispute that cannot be settled by negotiation within a specific timeframe should be referred to a particular regional institution for mediation. Or perhaps there are some issues which can potentially be settled by a technical committee, while other issues should automatically be referred to a ministerial council. Even if no such provisions make it into the final agreement, the time spent considering how best to resolve (and, even better, to avoid)disputes relating to the definition and use of a river boundary is unlikely to be time wasted.

5 Use and management of trans-boundary watercourses

5.1 Introduction

The uses of transboundary watercourses are many. These range from navigation, agricultural and industrial to environmental and human uses. The rules of international law regulate relations between States as well as their behaviour with respect to water resources management in their own jurisdiction. Where a watercourse crosses an international boundary, or where an international boundary follows a watercourse, riparian States must cooperate with each other.

This chapter provides an insight into the legal frameworks, principles and interests pertinent to the use and management of transboundary water resources by riparian States. It surveys the relevant instruments, seminal case law and specific uses, both of a navigational and non-navigational nature, as well as the developing protection for human needs and the environment in relation to boundary watercourses.

5.2 Key instruments in the use and management of transboundary water resources

A variety of instruments exist at the universal, regional and basin levels to regulate the uses of transboundary water resources. At the universal level, the most prominent is the 1997 United Nations Convention on the Non-navigational Uses of International Watercourses,[49] which entered into force in 2014.[50] Prior to this, the 1992 United Nations Economic Commission for Europe (UNECE) Convention on the Protection and Use of Transboundary Watercourses and International Lakes entered into force in

[49] United Nations Convention on the Non-navigational Uses of International Watercourses 1997 (UN Watercourses Convention); 36 ILM 700. https://legal.un.org/ilc/texts/instruments/english/conventions/8_3_1997.pdf.

[50] At the time of writing there are 36 parties, of which 12 are African countries: Benin, Burkina Faso, Chad, Côte d'Ivoire, Guinea-Bissau, Libya, Morocco, Namibia, Niger, Nigeria, South Africa, Tunisia.

1996 and is open to non-UNECE States.[51] Furthermore, the 2008 International Law Commission (ILC)[52] Draft Articles on the Law of Transboundary Aquifers[53] is another universally relevant non–binding instrument, which reflects some of the applicable principles of customary international law.

Universal codification leaves space for particularities in the formulation of norms at the regional and basin level. Regional agreements include the 1999 UNECE Protocol on Water and Health, the 2003 UNECE Protocol on Civil Liability and Compensation for Transboundary Damage, the 2000 SADC Revised Protocol on Shared Watercourses and the 2000 Directive of the European Parliament and of the Council establishing a Framework for Community Action in the Field of Water Policy. At the basin level, many agreements exist as well. For example, the 1978 Amazon Cooperation Agreement, the 1995 Cooperation Agreement for Sustainable Development of the Mekong River Basin, the 1999 Rhine Protection Convention, the 2002 Senegal Water Charter, and the 2008 Niger Basin Water Charter.

Universal, regional and basin instruments can influence and supplement each other. Universal instruments, such as the 1997 UN Watercourses Convention, provide for certain fundamental principles that may be included in regional and basin agreements while regional and basin agreements can be tailored to the specifics of individual watercourses or basins.

5.3 The law applicable to navigational uses

Navigation activities constitute one of the oldest forms of utilizing international watercourses. Freedom of navigation is generally understood as

[51] Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Helsinki, 17 March 1992); UNTS 1936 (1992); ILM 1312 (1992), https://www.unece.org/env/water/text/text.html. Chad and Senegal have become parties to the Convention.

[52] The International Law Commission was created by the United Nations General Assembly in 1947. It assists the UN General Assembly with its task under Article 13(1)(a) of the UN Charter of 'initiat[ing] studies and mak[ing] recommendations for the purpose of […] encouraging the progressive development of international law and its codification'.

[53] 2008 ILC Draft Articles on the Law of Transboundary Aquifers; Official Records of the General Assembly, Sixty-third Session, Supplement No. 10 (A/63/10), https://legal.un.org/ilc/texts/instruments/english/draft_articles/8_5_2008.pdf.

a freedom to transport persons or merchandise on international watercourses.[54] The principle entails the freedom of the movement of ships and boats along the entire course of an international watercourse.[55] The regime of freedom of navigation has evolved over time and differed between continents. As such, the late nineteenth and early twentieth centuries saw a profound liberalisation in this respect, notably on the European, African, and Asian continents. It gained momentum through the pursuit of colonial and commercial interests by European powers in many regions of the world.[56]

In Africa, the 1972 Convention Relating to the Statute of the Senegal River restricts the application of the principle of freedom of navigation to ships flying the flags of Contracting States only[57] and in Asia the 1995 Agreement on Cooperation for the Sustainable Development of the Mekong River Basin provides for the application of this principle to all riparian States. The navigation regime on the American continent has been restricted to either riparian countries[58] or Contracting Parties.[59] These examples of international practice serve as a reminder of the importance that riparian States in various parts of the world attach to the principle of freedom of navigation. It needs to be pointed out that this principle takes its substance from economic, historic, and political realities that are specific to each waterway and each region. It can be said that the principle of freedom of navigation for riparian States is a rule of customary international law, but certain regimes can specify or derogate from this.[60]

---

[54] See, for example, Article 14(c) of the Helsinki Rules on the Uses of the Waters of International Rivers (1966) and Article 43(5)(c) of the Berlin Rules on Water Resources adopted by the International Law Association (2004).

[55] See Article 43(4) of the Berlin Rules on Water Resources adopted by the International Law Association in 2004.

[56] See General Act of the Berlin Conference, which includes the extension of a liberal regime as regards navigation to the Congo and Niger rivers. 'Acte général de la Conférence de Berlin' in J. Hopf (ed) (1885) *Recueil général de traités et autres actes relatifs aux rapports de droit international,* Deuxième série, Tome X (Göttingen: Librairie de Dietrich), 416-18.

[57] Convention Relating to the Status of the Senegal River (Nouakchott, 11 March 1972), in *Documents of African Regional Organizations III* (New York: Oceana, 1973), Article 6.

[58] See Treaty between Uruguay and Argentina concerning the Rio de la Plata and the Corresponding Maritime Boundary (Montevideo, 19 November 1973; ILM 13 (1974)), Article 7.

[59] See Amazon Cooperation Treaty (Brasilia, 3 July 1978; UNTS 1202 (1980)), Art 3.

[60] International Law Association, Berlin Conference on Water Resources Law – Berlin Rules 2004, Art 43 and 45, available at www.unece.org/fileadmin/DAM/env/water/meetings/legal_board/2010/annexes_groundwater_paper/Annex_IV_Berlin_Rules_on_Water_Resources_ILA.pdf.

Other freedoms can be derived from this principle. In the Oscar Chinn Case, for example, the Permanent Court of International Justice considered that the freedom of navigation included 'freedom of movement for vessels, freedom to enter ports, and to make use of plant and docks, to load and unload goods and to transport goods and passengers'.[61] Freedom of navigation is not solely concerned with the movement of boats. Rather, in some cases, it can cover engagement in commercial activities related to the transportation industry, as is illustrated by the abovementioned Oscar Chinn Case. Indeed, the idea that has long underpinned the establishment of the right of free navigation in international practice is the assurance of concerned States' economic interests.

5.4 The law applicable to non-navigational uses

Non-navigational uses, such as irrigation, industrial, recreational and human uses, became more and more important in the course of the 20th century. Economic development and population growth resulted in an increase in demand for water. These factors and the concerns about limited availability of water resources as well as growing awareness of the need for their protection led to the adoption of the 1966 Rules on the Uses of the Waters of International Rivers, the so-called 'Helsinki Rules', which deal with navigational as well as non-navigational uses of rivers.[62] These rules, which have been drafted by the International Law Association (ILA), a non-governmental association of legal experts, codified principles derived from State practice with the objective of clarifying the rules applicable to the use, sharing, and management of international watercourses.

In 1970, the UN General Assembly adopted Resolution 2669, which entrusted the International Law Commission with the task of initiating a

[61] The Oscar Chinn Case, Judgment, PCIJ Reports 1934, Series A/B, No 63, 83.

[62] See International Law Association, *Report of the Fifty-second Conference* (London: International Law Association, 1967), 506. See also E. Manner and V.-M. Metsälampi (eds) (1988), *The Work of the International Law Association on the Law of International Water Resources* (Helsinki: Finish Branch of the International Law Association).

study on the law of non-navigational uses of international watercourses.[63] The completion of the work of the Commission, which took almost three decades, led to the adoption by the General Assembly on 21 May 1997 of the UN Watercourses Convention. It covers all uses other than navigation.

It is interesting to note that both the UN Watercourses Convention and the works which led to its adoption (i.e. the ILC's Draft Articles on the Non-navigational Uses of International Watercourses)[64] have been taken into account for formulating international agreements in a variety of contexts. One such case is the draft of a cooperative framework for the sustainable and equitable use of the resources of the Nile Basin, which was developed with the support of the World Bank, UNDP, and other multilateral and bilateral donors and was adopted in 2010 by some of the Nile riparians.[65] Another such case has been the Revised Protocol on Shared Watercourses in the Southern African Development Community.[66]

The UN Watercourses Convention lays down the main building blocks for water management at the international level.[67] Such foundations delineate the path for an integrated approach composed of four main pillars, while a fifth, which has only been elaborated in a very limited way, deserves further exploration and refinement.

The water sharing principles constitute the **first pillar.** They comprise the 'equitable and reasonable use' principle and the 'no-harm rule'. The first

[63] See Resolution 2669 (XXV) of the General Assembly, 'Progressive development and codification of the rules of international law relating to international watercourses' (8 December 1970), paragraph 5.

[64] The ILC's Draft Articles on the Non-navigational Uses of International Watercourses were adopted at its 43rd session in 1991. Following receipt of States' comments, the Commission proceeded to a second reading of the Draft Articles in 1994 at its 46th Session. These articles constituted the basis of the UN Convention which was ultimately adopted by the General Assembly in 1997.

[65] See Agreement on the Nile River Basin Cooperative Framework (2009), available at www.internationalwaterlaw.org/documents/regionaldocs/Nile_River_Basin_Cooperative_Framework_2010.pdf.

[66] Revised Protocol on Shared Watercourses in the Southern African Development Community, 7 August 2000, available at www.internationalwaterlaw.org/documents/regionaldocs/Revised-SADC-SharedWatercourse-Protocol-2000.pdf. See also S. Salman (2001) 'Legal Regime for Use and Protection of International Watercourses in the Southern African Region: Evolution and Context', Natural Resources Journal, 41(4), 981. The Charter of Water of the Senegal River, 2002 (www.tematea.org/?q=node/6580), the Water Charter of the Niger River Basin, 2008 (www.riob.org/riob/information-et-publications/article/la-charte-de-l-eau-du-bassin-du) and the Charter of Water of the Lake Chad Basin, 2011 (www.africanwaterfacility.org/fileadmin/uploads/awf/Projects/MULTIN-LAKECHAD-Water-Charter.pdf) all refer in their Preambles to the UN Watercourses Convention

[67] For a detailed explanation and analysis of its provisions, see L. Boisson de Chazournes *et al.* (eds) (2018) *The UN Convention on the Law of the Non-Navigational Uses of International Watercourses: A Commentary* (Oxford University Press).

principle is set out in Article 5 and provides that watercourse States should use international watercourses within their territories in an equitable and reasonable way. This means, in particular, that use of the watercourse is optimal and sustainable, and takes into account the interests of other concerned watercourse States. Optimal utilization means seeking the maximum possible benefits for all watercourse States as well as meeting as many needs as possible while minimizing the detrimental effects of using the watercourse.[68] Article 7 articulates the 'no-harm' rule, which requires States to adopt measures that prevent, mitigate or compensate harm to other watercourse States.

The **second pillar** is the riparian States' general obligation to cooperate. According to the UN Watercourses Convention, such cooperation may be achieved through different means: setting joint mechanisms and commissions of which riparians are members, regular exchange of information and data and notification of planned measures. Since the collection and exchange of data are key elements for preventing disputes, the establishment of joint mechanisms and commissions should be further strengthened to promote adequate systems for the exchange of information, which are also envisaged in Article 8, paragraph 2 of the UN Watercourses Convention. It is a due diligence-type obligation that does not limit States to any precise outcome. One encounters similar language in the first paragraph of Article 24, which provides that States should consult on the management of an international watercourse.

There are numerous uses of international watercourses and international law does not impose a hierarchy or privilege certain uses over others. That said, special regard should be given to the requirements of vital human needs.[69] The principles of equitable and reasonable utilization and the obligation not to cause significant harm should guide the parties in their search for a mutually agreed solution as well as to the requirements derived from satisfying vital human needs.

[68] See L. Caflisch (2018) 'Equitable and Reasonable Utilization and Factors Relevant to Determining Such Utilization (Articles 5 and 6)' in L. Boisson de Chazournes *et al.* (eds) *The UN Convention on the Law of the Non-Navigational Uses of International Watercourses: A Commentary* (Oxford University Press).

[69] See, for example, International Law Association, Berlin Conference on Water Resources Law – Berlin Rules 2004, Art 14(2); UN Watercourses Convention, Article 10(2).

Moreover, efforts should be made to ensure that these institutional settings are opened to all riparians. This may entail some degree of flexibility by allowing all riparians of a particular international watercourse system – whether or not parties to a given watercourse agreement – to participate, as observers or in a similar capacity, in the work and activities of a joint mechanism established in that context. As part of the confidence-building spirit that is key to promoting integrated water management, the granting of such observer-like status would constitute a first step towards the further involvement of such 'outsider' States as parties to an eventual agreement encompassing all riparians.

The **third pillar** integrates the protection of the environment as a component of the regime applicable to international watercourses with obligations dealing with the protection of the ecosystems of international watercourses and the prevention and control of pollution. Part IV of the UN Watercourses Convention, concerned with environmental protection, is phrased mostly in general terms. The environmental regime needs to be strengthened to incorporate principles and rules of international environmental law, including the principles enunciated in the Rio Declaration on Environment and Development. The UNECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes (1992) is quite illustrative in this respect.

The **fourth pillar** is the promotion of dispute settlement and dispute avoidance mechanisms. While the Convention provides for the traditional menu of diplomatic and judicial means of dispute settlement between States, a significant addition is the fact-finding commission that can be established at the request of a party. Nevertheless, some issues remain to be clarified. One is the role played by the scientific community in the dispute settlement process and the need for it to be fully incorporated. Another issue relates to enforcement measures to be decided upon for ensuring effective compliance with international watercourse agreements. This stresses the importance of riparians making appropriate agreements or arrangements, and international development assistance plays a role in this respect.

Lastly, a **fifth** – less-developed – **pillar** concerns the involvement of non-State actors. The UN Watercourses Convention is a classically State-oriented instrument, with almost no provisions on the involvement of

other stakeholders, notably local communities and non-governmental organisations. Notwithstanding, it contains one provision that deals with individuals, ensuring their access to judicial and other procedures on a non-discriminatory basis.[70]

5.5 Seminal case law on the use and management of transboundary rivers and water resources

A number of cases at the international level are notable for their engagement with the use and management of transboundary water resources.

5.5.1 Gabčìkovo-Nagymaros (Hungary/Slovakia) 1997

The dispute over the *Gabčikovo-Nagymaros* project settled by the International Court of Justice (ICJ) in 1997 centred on the 1977 Treaty between Hungary and Czechoslovakia (from 1993 Slovakia).[71] It provided for the construction of two series of locks, one at Gabčikovo, in the territory of Czechoslovakia, and the other at Nagymaros in Hungary. As a result of intense criticism generated by the project in Hungary, in 1989 the Hungarian government decided to suspend and then to abandon the project. Czechoslovakia worked out various alternative solutions but Hungary maintained that further environmental studies were required before construction could be pursued. The failure of negotiations paved the road for the undertaking of unilateral actions: Czechoslovakia started to work on Variant C which entailed, among other things, a unilateral diversion of the Danube by Czechoslovakia on its territory and the construction of a dam and two hydroelectric plants. During this phase, Hungary notified Czechoslovakia of the termination of the 1977 Treaty.

[70] UN Watercourses Convention, Article 32.

[71] *Case concerning the Gabčikovo-Nagymaros Project* (Hungary/Slovakia), Judgment, 1997 (www.icj-cij.org/files/case-related/92/092-19970925-JUD-01-00-BI.pdf).

In 1993, Hungary and Slovakia submitted their dispute to the ICJ. In 1997, the ICJ decided that the 1977 Treaty remained in force and that Slovakia was not entitled to put Variant C into operation. The Court considered whether Variant C could be considered as a lawful countermeasure and recalled that the 'effects of a countermeasure must be commensurate with the injury suffered, taking account of the rights in question'.[72] It ultimately concluded that the countermeasure was unlawful by reason of the fact that it deprived Hungary of its right to a fair and reasonable share of the natural resources of the Danube.[73] The Court left the parties to negotiate an agreement that would put an end to their dispute on the basis of the Court's decision. In the words of the Court:

> *It is not for the Court to determine what shall be the final result of these negotiations to be conducted by the Parties. It is for the Parties themselves to find an agreed solution that takes account of the objectives of the Treaty, which must be pursued in a joint and integrated way, as well as the norms of international environmental law and the principles of the law of international watercourses.*[74]

Since then, however, a negotiated solution was not found, although the proceedings have been discontinued at the Court.

5.5.2 Pulp Mills (Argentina v. Uruguay) 2010

In the *Pulp Mills on the River Uruguay* case involving Argentina and Uruguay, the ICJ considered the obligations of riparian States in respect of projects likely to have an environmental impact on a shared watercourse.[75] Indeed, the Court's ruling in the Pulp Mills case reinforces the

[72] *Ibid*, paragraph 85.

[73] *Ibid*.

[74] *Ibid*, paragraphs 141-42.

[75] *Pulp Mills on the River Uruguay*, Judgment, 2010 (www.icj-cij.org/files/case-related/135/135-20100420-JUD-01-00-BI.pdf).

importance of riparian neighbours' obligations of consultation and cooperation to their mutual objective of optimal use of shared waters. This dispute, which the Court described as emphasizing 'the need to ensure environmental protection of shared natural resources while allowing for sustainable economic development', [76] arose from an allegation by Argentina that Uruguay's authorization of pulp plant construction on the Uruguay river breached procedural obligations under the 1975 Statute of the River Uruguay, and involved risks of environmental degradation. Because Uruguay did not inform the States' joint administrative commission of its planned pulp mills on the Uruguay river before authorizing the works, the Court found that it had violated its consultation obligations. Specifically concerning the duty to negotiate, the Court also noted that unilateral Uruguayan authorization of the pulp mills prior to the expiration of the treaty-prescribed negotiation period evidenced a disregard for such cooperative mechanisms that amounted to a violation of this procedural obligation. [77]

More broadly, the Court observed that – due to widespread State practice – 'it may now be considered a requirement under general international law [and due diligence] to undertake an environmental impact assessment where there is a risk that the proposed industrial activity may have a significant adverse impact in a transboundary context, in particular, on a shared resource'. [78] The Court affirmed that this notification must occur before any implementation or decision on the environmental viability of a proposed project, and must be updated as needed during the life of the project through continuous monitoring. However, the Court found no similar consensus in general international law as to the scope and content of environmental impact assessments, and in the absence of any reference to this in the 1975 Statute, it remained for each of the neighbouring States to determine the proper content of an assessment. [79]

[76] *Pulp Mills on the River Uruguay*, Provisional Measures, Order of 13 July 2006, paragraph 80 (www.icj-cij.org/files/case-related/135/135-20060713-ORD-02-00-BI.pdf).

[77] *Pulp Mills on the River Uruguay*, Judgment, paragraph 149.

[78] *Ibid*, paragraph 204.

[79] *Ibid*, paragraph 205.

5.6 Human needs and environmental flow

In addition to the Gabčìkovo-Nagymaros and Pulp Mills case, the ICJ has adjudicated a number of cases involving water and boundary issues: the Kasikili/Sedudu Island case in 1999,[80] the Cameroon v Nigeria dispute in 2002,[81] the 2005 case of Benin/Niger,[82] and those of Costa Rica v Nicaragua in 2009 and Burkina Faso/Niger in 2013.[83] In some of these cases, as will be seen, the Court referred to the uses of the concerned watercourses. These uses have included those related to human needs of local populations. Indeed, human needs have permeated the law applicable to fresh water through a variety of avenues. Overall, human needs have to be taken into account but they rarely have an influence on the determination of the boundary itself.[84]

The emergence of the recognition of the right to water is emerging in both human rights frameworks and in international water law. As for the latter, the Protocol on Water and Health of 1999 to the Convention on the Protection and Use of Transboundary Watercourses and International Lakes of 1992,[85] the Charter of Water of the Senegal River of 2002,[86] the Water Charter of the River Niger Basin,[87] and the Charter of Water of Lake Chad,[88] are examples of watercourse conventions that contain this right. It provides for access to water for domestic uses. It also entitles riparian

[80] *Case concerning Kasikili/Sedudu Island (Botswana v Namibia)*, Judgment, 1999 (www.icj-cij.org/files/case-related/98/098-19991213-JUD-01-00-BI.pdf).

[81] *Land and Maritime Boundary between Cameroon and Nigeria (Cameroon v Nigeria: Equatorial Guinea intervening)*, Judgment, 2002 (www.icj-cij.org/files/case-related/94/094-20021010-JUD-01-00-BI.pdf).

[82] *Frontier Dispute (Benin/Niger)*, Judgment, 2005 (www.icj-cij.org/files/case-related/125/125-20050712-JUD-01-00-BI.pdf).

[83] *Dispute Regarding Navigational and Related Rights (Costa Rica v Nicaragua)*, Judgment, 2009 (www.icj-cij.org/files/case-related/133/133-20090713-JUD-01-00-BI.pdf); *Frontier Dispute (Burkina Faso/Niger)*, Judgment, 2013 (www.icj-cij.org/files/case-related/149/149-20130416-JUD-01-00-BI.pdf).

[84] See *Frontier Dispute (Burkina Faso/Niger)*, Judgment, 2013; *Frontier Dispute (Burkina Faso v Mali)*, Judgment, 1986 (www.icj-cij.org/files/case-related/69/069-19861222-JUD-01-00-BI.pdf).

[85] Protocol on Water and Health of 1999 to the Helsinki Convention of 1992, Arts 1, 4, paragraph 2(a) and (b), paragraph 1(a) and (b); www.unece.org/fileadmin/DAM/env/documents/2000/wat/mp.wat.2000.1.e.pdf.

[86] The Charter of Water of the Senegal River of 2002, Art 4; www.tematea.org/?q=node/6580.

[87] Water Charter of the Niger River Basin 2008; www.riob.org/riob/information-et-publications/article/la-charte-de-l-eau-du-bassin-du.

[88] The Charter of Water of the Lake Chad Basin 2011; www.africanwaterfacility.org/fileadmin/uploads/awf/Projects/MULTIN-LAKECHAD-Water-Charter.pdf.

communities to be consulted on and participate in the management of a transboundary watercourse.

Human needs have also had an influence in the context of fishing activities. In fact, the possibility of fishing in waters that fall under the sovereignty of another riparian State[89] can be guaranteed to the riparian populations of a shared watercourse. The ICJ in the Dispute Regarding Navigational and Related Rights (Costa Rica v Nicaragua) Case underscored that customary fishing rights can be defined as rights which result from a long and uncontested practice of fishing activity by riparians.[90] In the Case Concerning Kasikili/Sedudu Island, the Court did not simply identify the boundary around Kasikili/Sedudu, but rather concerned itself with safeguarding the traditional activities of the local population, such as fishing, by reminding the parties of their commitment to cooperate.[91] Similarly, in the Frontier Dispute (Benin/Niger) case of the ICJ concerning the boundary delimitation along the Niger and Mekrou rivers, as well as the ownership of several river islands, inhabitants in both States used the waters of the rivers. In determining the title of the islands at issue, the Court went on to emphasise that such a determination was 'without prejudice to any private law rights which may be held in respect of those islands'.[92] Further still, in the Frontier Dispute (Burkina Faso/Niger) case, human needs had an influence on the boundary delimitation as the Court expressed that it wished the parties to have 'due regard to the needs of the populations concerned' and encouraged the parties to cooperate in this respect.[93]

The concepts of minimum flow and environmental flow are found in the context of the uses of watercourses and their associated legal obligations. In the context of a dispute between India and Pakistan, the Indus Waters Kishenganga arbitration has shed light on this concept.[94] The tribunal considered the concept of minimum flow in an environmental context. It referred to the requirement of 'the maintenance of a minimum

[89] See *Dispute Regarding Navigational and Related Rights* (Costa Rica v Nicaragua), Judgment, 2009, paragraphs 134-44.

[90] *Ibid*, paragraph 141.

[91] *Case Concerning Kasikili/Sedudu Island (Botswana v Namibia)*, Judgment, 1999, paragraphs 102-3.

[92] *Frontier Dispute (Benin/Niger)*, Judgment, 2005, paragraph 118.

[93] *Frontier Dispute (Burkina Faso/Niger), Judgment, 2013, paragraph 112.*

[94] *Indus Waters Kishenganga Arbitration (Pakistan v. India)*, PCA Final Award, 20 December 2013.

flow downstream of the [concerned hydroelectric project] in response to considerations of environmental protection'.[95] While doing so, the tribunal took into account the various uses at stake, as well as the requirement to protect the environment. While there is no specific definition of the concepts of minimum flow and environmental flow, treaty practice provides some insights as to their meaning. They relate to the maintenance of a quantity of water in the main channel of a watercourse or an obligation to control water flow.[96]

5.7 Conclusion

International law has long governed shared watercourses. That said, over time international law has gradually taken account of the wide range of uses of international watercourses. As it has done so, the need for co-operation between riparian States has come into sharper focus. Going forward, the rule of law will be central to solving the multiple challenges that arise from cross-boundary watercourses. Bringing with it stability and predictability, the rule of law also contributes both to the avoidance and settlement of disputes in this area.

[95] Ibid., at paragraph 455.

[96] For examples of treaty practice, see Treaty on the Lesotho Highlands Water Project Between the Government of the Kingdom of Lesotho and the Government of the Republic of South Africa, Article 6(9), (24 October 1986), available at www.fao.org/docrep/W7414B/w7414b0w.htm; Agreement on the Cooperation for the Sustainable Development of the Mekong River Basin 1995, 2069 UNTS 3, Article II(3); and the Water Charter of the River Niger Basin 2008, Article 11(1), available at www.africanwaterfacility.org.

6 General conclusions

Rivers are complex features of the physical world, and boundaries which follow rivers often present significant challenges for governments. Many existing river boundary definitions do not specify where in the river the boundary is located, creating the need for negotiations to refine the definition. Others refer to a line which is not easy to locate with precision and which, in any case, is likely to move over time. Even when the boundary has been defined to the satisfaction of both riparian States, it may still be necessary to agree management regimes that ensure equitable and efficient access to and use of a shared river.

The are no clear international legal rules concerning the definition of river boundaries. International law concerning the use and management of transboundary watercourses (including boundary rivers) is more developed, but much of that law concerns broad rights and responsibilities rather than the practical issues that often arise at a local level. It is therefore understandable if governments find river boundaries a rather daunting proposition.

The physical and human geography of boundary rivers in Africa vary greatly. So do political and economic relations between neighbouring States. It would therefore be foolish to argue that there is a single recommended solution to river boundary definition and management. From a distance, it is tempting to suggest that a 'flexible' river boundary (a boundary that moves with the river) is more practical than a fixed line. It is also generally desirable to maximise access to the full river channel from both banks. However, in some cases local and national realities mean that such approaches would create as many problems as they solve. Each river boundary must be considered in its own context, and some river boundaries demand different approaches in different sections.

This guide book has sought to highlight issues that governments should consider when addressing river boundaries and transboundary rivers. Although it has almost certainly not answered every question that a government may have, it has hopefully identified some good practice and useful resources which will enable stakeholders to have informed discussions and to think creatively about potential solutions to the practical challenges that they face. River boundaries often require more work than overland boundaries in terms of both definition and management. However, with goodwill, cooperation and flexibility they can function just as effectively. Indeed, boundary rivers which are treated as a shared resource can become powerful symbols of cooperation and bridge-building between neighbouring States.

Fishing on the Congo River between Kinshasa and Lukolela, Democratic Republic of Congo. Photo © Ollivier Girard/CIFOR

7 Recommended further reading

7.1 River boundaries

Biger, G. (1988) Physical geography and law: the case of international river boundaries, *GeoJournal, 17(3)*

Bouchez, L. J. (1963) The fixing of boundaries in international boundary rivers, International and Comparative Law Quarterly 12

Donaldson, J.W. (2011) Paradox of the Moving Boundary: Legal Heredity of River Accretion and Avulsion, Water Alternatives 4(2); available at http://www.water-alternatives.org/index.php/allabs/137-a4-2-4/file

Gleditsch, K. (1952) Rivers as international boundaries, *Nordisk Tidsskrift for International Relations 22*

Jones, S.B. (1945) Boundary-Making: A Handbook for Statesmen, Treaty Editors and Boundary Commissioners, Washington: Carnegie Endowment for International Peace; especially chapter 6 ('River Boundaries')

McEwen, A.C. (1971) International Boundaries of East Africa, Oxford: Clarendon Press; especially chapter 6 ('River Boundaries')

Querol, M. (2016) Freshwater Boundaries Revisited: Recent Developments in International River and Lake Delimitation, Brill Research Perspectives

Schroeter, F. (1992) Le Système de Délimitation dans les fleuves internationaux, *Annuaire Français de Droit International*, XXXVIII ; available at https://www.persee.fr/doc/afdi_0066-3085_1992_num_38_1_3103

7.2 Hydrology and river mechanics

Gregory, K.J. and Walling, D.E. (1973) *Drainage Basin Form and Process, London: Edward Arnold*

Knighton, D. (1998) Fluvial Forms and Processes: A New Perspective, London: Hodder Arnold (republished 2014 by Routledge)

7.3 Use and management of transboundary watercourses

Boisson de Chazournes, L., Mbengue, M., Tignino, M., Sangbana, K., and Rudall, J. (eds) (2018) *The UN Convention on the Law of the Non-Navigational Uses of International Watercourses: A Commentary*, Oxford: University Press

Boisson de Chazournes, L. (2013 in hardback, 2015 in paperback) *Fresh Water in International Law*, Oxford: University Press

Boisson de Chazournes, L. and Salman, S.L.A. (eds) (2005) *Water Resources and International Law, Leiden/Boston: Hague Academy of International Law/Nijhoff*

Boisson de Chazournes, L., and Tignino, M. (2010) 'Le règlement des différends internationaux relatifs à l'eau', *L'eau et son droit*, Etudes et documents du Conseil d'Etat, Paris, La documentation française; available at https://www.conseil-etat.fr/Media/actualites/documents/reprise-_contenus/etudes-annuelles/eau_droit_rapport.pdf

Mubiala, M. (1995) *L'évolution du droit des cours d'eau internationaux à la lumière de l'expérience africaine, notamment dans le bassin du Congo/Zaïre*, Institut de Hautes Etudes Internationales, Genève, PUF, Paris ; available at https://books.openedition.org/iheid/1537

8 About the authors

Professor Paul Bishop, Emeritus Professor of Physical Geography and Honorary Senior Research Fellow, University of Glasgow School of Geographical & Earth Sciences, UK

Paul is an Earth Scientist by training, with a PhD and a DSc from Macquarie University in Sydney, Australia. Prior to taking up the Glasgow post in 1998, he was the Director of the Graduate School of Environmental Science at Monash University in Melbourne, Australia. The focus of his research is rivers and landscape history. He has consulted for the Mekong River Commission on international boundary disputes on the Mekong, and advised Southeast Asian governments on similar issues. He has also tutored on several workshops on river boundaries organised by IBRU: Centre for Border Studies at Durham University. Paul was elected a Fellow of the Royal Society of Edinburgh in 2004, a Fellow of the Geological Society of America in 2011, and a Fellow of the British Society for Geomorphology in 2014.

Professor Laurence Boisson de Chazournes, Professor, University of Geneva; Director of the Geneva LL.M. in International Dispute Settlement (MIDS); Director of the Geneva Water Hub's Platform for International Water Law

Laurence has published widely in the areas of international environmental law, international water law and dispute settlement. She was a member of the Global High-Level Panel on Water and Peace (2015-2017). In the field of dispute settlement, Laurence acts as an arbitrator in investor-State disputes. She is also a counsel before the International Court of Justice and has acted in renowned international environmental law cases (Legality of the Threat or Use of Nuclear Weapons (1996), Pulp Mills on the River Uruguay (2010) and Whaling in the Antarctic (2014)). In 2008 Laurence received the Elizabeth Haub Prize for Environmental Law.

Professor Martin Pratt, Director, Bordermap Consulting

Martin is an internationally respected expert in boundary-making, border management and territorial dispute resolution, with over twenty-five years' experience working with governments, international organisations, businesses, scholars and practitioners around the world to resolve and prevent boundary-related conflict. He has extensive practical experience in boundary negotiations and third-party adjudication of boundary and sovereignty disputes. Martin worked at Durham University's IBRU: Centre for Borders Research from 1994-2015, leading the Centre's consultancy and professional training programmes for over a decade, with a particular focus on geographical and technical aspects of boundary delimitation. He has served as an advisor to the African Union Border Programme and has worked with several African governments on river boundary issues.

African Union

SILENCING THE GUNS.
Towards a Peaceful and Secure Africa

African Union Border Programme (AUBP)
Department for Political Affairs, Peace and Security
African Union Commission
Email: Situationroom@africa-union.org
Tel: +251 (0) 11552 6373
Twitter: @AUC_PAPS
Facebook: https://www.facebook.com/au.paps
Website: www.peaceau.org