AMPHIBIAN
COLOMBIA

A country **of wetlands**

COLOMBIA **ANFIBIA**
Un país **de humedales**

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AMPHIBIAN

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INSTITUTO DE INVESTIGACIÓN DE RECURSOS BIOLÓGICOS ALEXANDER VON HUMBOLDT
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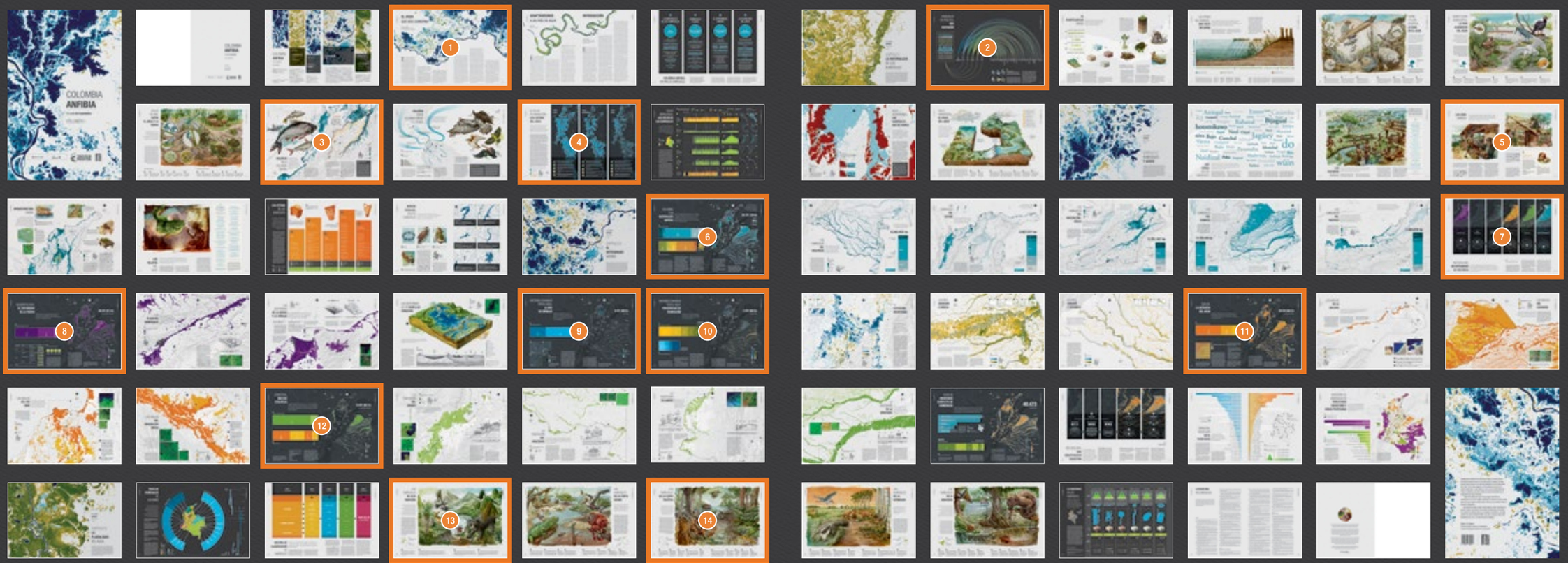
These are miniatures of the complete publication in Spanish of *Amphibian Colombia. A country of wetlands.* The selected content is highlighted in orange.



CONTENTS

During 2010 and 2011, Colombia witnessed the consequences of La Niña phenomenon that caused precipitations above those historically observed. Due to the lack of tools and adaptation measures, the phenomenon left nearly 3,219,200 people damnified and caused several material damages. In response to this event, the project *Insumos Técnicos para la Delimitación de Ecosistemas Estratégicos: páramos y humedales* (Technical Tools for Delimitation of Strategic Ecosystems: paramos and wetlands) was established, developed between the *Instituto de Investigación de Recursos Biológicos Alexander von Humboldt* (Alexander von Humboldt Research Institute of Biological Resources) and *Fondo Adaptación* (Adaptation Fund), in order to guide the management of strategic ecosystems such as paramos and wetlands, and strengthen risk management in the country and the ability to adapt to climate change. Thus, *Amphibian Colombia. A country of wetlands* is born, which seeks to promote an acknowledgment and understanding of Colombia as an amphibian territory in which a great part of its geography and culture are directly associated to water. You hold in your hands a careful selection of the complete work, a result of more than two years of research, whose contents will allow you to have a first approach to our country of water: amphibian Colombia.

IT IS WATER
THAT GOVERNS US

Brigitte L. G. Baptiste
General Director, Instituto de Investigación de Recursos Biológicos
Alexander von Humboldt
(Alexander von Humboldt Research Institute of Biological Resources)

AMPHIBIAN COLOMBIA

Water connects everything. It is the governing principle of ecosystem functioning and society, and variations in this connectivity, in time and space, define the possibilities of building culture, its modalities. The different human groups devise how to adapt to water availability, to its mobility, to its qualities, just as animal and plant species have done throughout the history of the planet, except that humans have done so with a distinct interpretive means, the ability to see the future. At least, partially. The ability to anticipate, unfortunately, is operating in our country like Cassandra's curse: we see, but destiny seems unescapable. In spite of the accumulated knowledge, the information available, the evidence, the management of our relations with water is far from adaptive. On the contrary, we insist on deepening Colombians' conditions of vulnerability by refusing to acknowledge the territory's qualities, the ecological transformations we have subjected it to, the forces we have unleashed.

In times of climate change, Colombia's privilege as a country of water should be considered a fundamental adaptation factor, as an evident and accessible resource to defend the long term welfare of everyone and, thus, as a resource of superior interest for defining development policies. Water management is at the base of sustainability, it is a part of our patrimony. The delimitation of paramos in the Equatorial high mountains is a part of this effort, and its management under scientific standards, combined with local and practical knowledge of all the country's wetlands, is its complement. It is the right direction, as we believe, to have the water cycle be truly interiorized within the cycle of environmental policy and its action plans: because to govern water, as we know from mythical times, is a pretentious illusion; it is water that governs us.

We present to the readers a book full of water and, with it, full of life. Colombian water, which is not the same as in any other place, because, although it flows in the same way as in all other parts of the world –from the cloud to the rain shower, from the mountain to the sea, from the river to the underground aquifer-, it tastes different, it is unique, since biodiversity drinks it, distributes it, colors it, carries it through all the labyrinths of its configurations, and, then, returns it. Because the water cycle flows within us and allows us to move fluently, even dance: this is the generosity of life, that it gives us the conditions of the fish and of the palm tree, and of the snake, and by just drinking, it makes us humid and allows us to construct civilizations. And since it is the water that flows through specific rocks, soils, fields, forests, grasslands, and crops, it is water with an identity that connects us with all of this. And if it stays in our cities, our industry, even embedded in metals, it is still its own: there is no watermark without name.

Colombian water is abundant, our Equatorial condition makes us pluvial, more than any other country, and that was never understood by the Castilians who brought their desert strategies and left us to inherit an association of rain with bad weather, for he who lives in drought distrusts the torrent, the generous lagoon, the vast river. There is too much life in it; a complex vision is required to decipher it, to coexist. The snake that dragged the woman to evil was not of the same species or from the same waters as the anaconda that created us in ours, and in the Judeo-Christian vision of both, its fertility was condemned, its abundance, misunderstood. But water continues to flow, and us, meanwhile resisting her, will just be dragged: desiccation to maintain livestock, irrigation districts, that are a risk when poorly managed, eroded reservoirs or dams, contaminated aquifers turn against us just as the flooding events of 2011 showed us, which led to the studies presented herein. Nevertheless, these were not new floods, since they have recurred two or three times each generation, and they will soon recur and make us consider that it would be good to recover our kinship with the *bocachico*, the alligator, and the frog.

Amphibian Colombia is an acknowledgment to the role of the founding water in the territory, to an underestimated story, to an empirical reality that all indigenous people and their mestizo descendants are aware of in their everyday lives, and that has sometimes resonated in the academy. We remember always the master Fals Borda and his *Historia Doble de la Costa*, the messages of the *cumbias*, the bountiful life of the fishermen in the narrations of rivers and large shores, so vilified. May this book bring you water, filled with toads and frogs, hicotea turtles, colored fish, palms; may it transform you into otters for a moment, make you remember the epic fish shoals, crabs, and dolphins, and may it have you remember that we are amphibian Colombia and that them, and us, we are more important than the gold and mercury that destroy us.

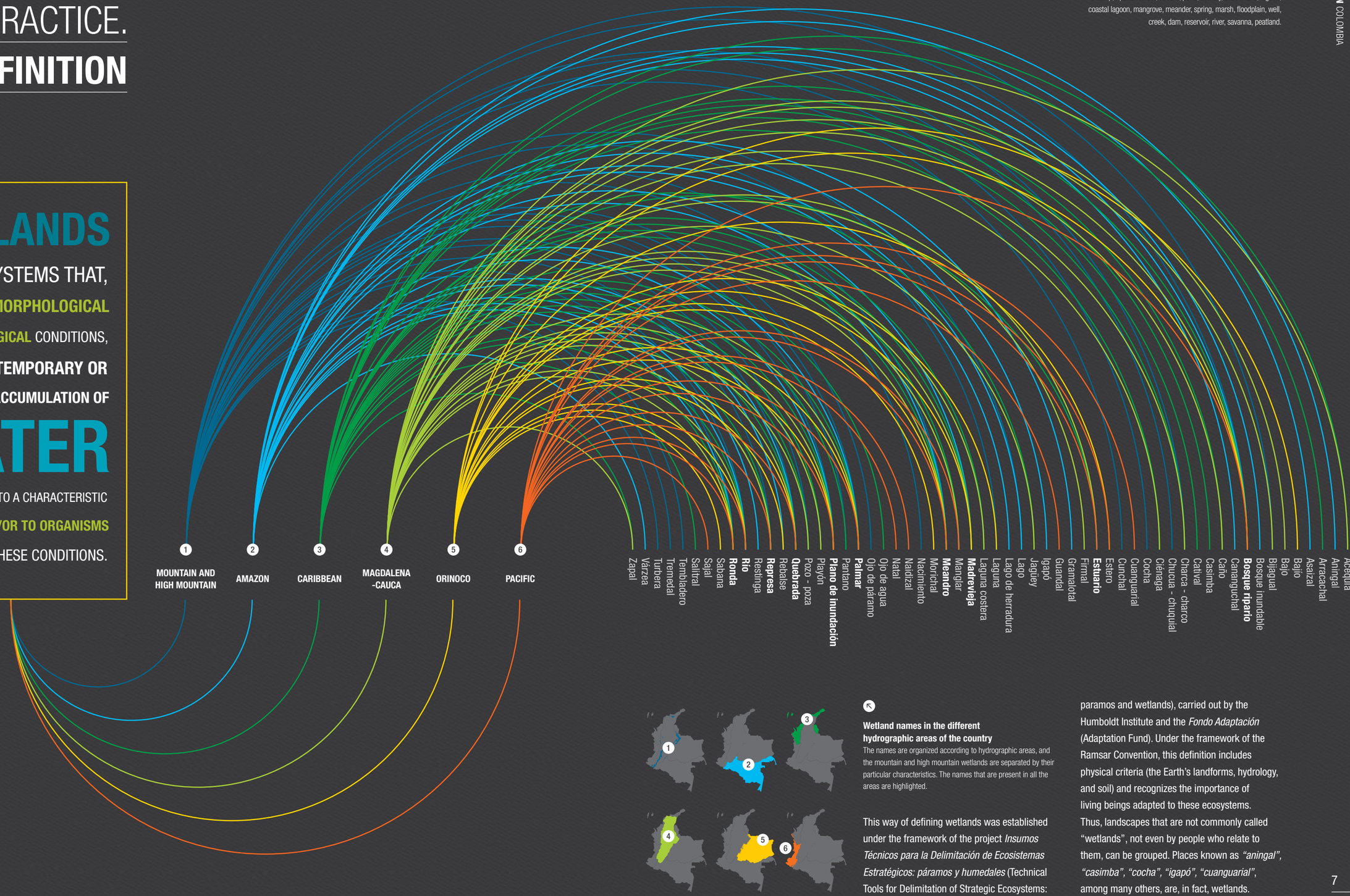
WETLANDS IN THE PRACTICE. A DEFINITION

WETLANDS

ARE ECOSYSTEMS THAT, DUE TO **GEOMORPHOLOGICAL** AND **HYDROLOGICAL** CONDITIONS, ALLOW THE **TEMPORARY OR PERMANENT ACCUMULATION OF**

WATER

AND GIVE PLACE TO A CHARACTERISTIC **SOIL TYPE AND/OR TO ORGANISMS** ADAPTED TO THESE CONDITIONS.



The wetland names presented below refer to specific types of wetlands in Colombia and have been left in their traditional language, Spanish; however, they belong to more general wetlands such as: swamp, riparian forest, stream, pond, estuary, oxbow lake, lagoon, coastal lagoon, mangrove, meander, spring, marsh, floodplain, well, creek, dam, reservoir, river, savanna, peatland.

Wetland names in the different hydrographic areas of the country
The names are organized according to hydrographic areas, and the mountain and high mountain wetlands are separated by their particular characteristics. The names that are present in all the areas are highlighted.

This way of defining wetlands was established under the framework of the project *Insumos Técnicos para la Delimitación de Ecosistemas Estratégicos: páramos y humedales* (Technical Tools for Delimitation of Strategic Ecosystems: paramos and wetlands), carried out by the Humboldt Institute and the *Fondo Adaptación* (Adaptation Fund). Under the framework of the Ramsar Convention, this definition includes physical criteria (the Earth's landforms, hydrology, and soil) and recognizes the importance of living beings adapted to these ecosystems. Thus, landscapes that are not commonly called "wetlands", not even by people who relate to them, can be grouped. Places known as *"aningal", "casimba", "cocha", "igapó", "cuanguarial"*, among many others, are, in fact, wetlands.

TRAVELERS IN THE AMPHIBIAN COLOMBIA

The life forms sheltered by rivers adapt to the water variability. Migratory fish are a clear example of how wetland changes set conduct patterns in animals, like a life clock.

In the Magdalena basin, wetland pulses and the subsequent connection and disconnection of the river with its *ciénagas* (swamps) determine the start and end of fish migrations and, in the particular case of the *bocachico*, the maturity of its gonads marks the beginning of the reproductive season. The balance of this chain is integral: affecting one of its parts can have repercussions on the rest.

A GREAT MIGRATOR

The longest movement recorded for the *bocachico* in the Magdalena-Cauca basin was of 1,224 km from the La Miel River (Caldas) 1 to the Chinchiná River (Caldas), at a velocity of 55.6 km/day. The fish swam downstream 2, entered the Cauca River 3, swam upstream in the Cauca 4, and entered the Chinchiná 5.

In this river, of bimodal behavior, some fish (16 of 129 known species in the middle part of this basin) make two upstream migrations (dry season) and two downstream migrations (high water season):

- ***SUBIENDAS* (UPSTREAM MIGRATIONS).** In low water season, fish migrate from the *ciénagas* (swamps) to the main river channel and ascend in search of rivers with clear and turbulent waters to release the eggs.
- ***BAJANZAS* (DOWNSTREAM MIGRATIONS).** After spawning, they return to the *ciénagas* (swamps) seeking food and shelter.

A few experiments in which fish have been tagged and recaptured have allowed the establishment of migration patterns. As a result, four species of the Magdalena basin have been recategorized according to the extension of their migrations – short (up to 100 km), medium (100-500 km), and long (over 500 km)–. Thus, the *chango* (*Cynopotamus magdalenae*) A, *doncella* (*Ageneiosus pardalis*) B, and *moino* or *comelón* (*Leporinus muyscorum*) C, previously reported as species with short migrations, are now considered to have medium migrations, while the *bocachico* (*Prochilodus magdalenae*) D has long, not medium, migrations.

CAMINE PEZ ("LET'S GO FISH") PROJECT

This work consisted of tagging migratory fish captured in the La Miel (Caldas) and Sogamoso (Santander) Rivers. A tag was adhered below the dorsal fin, made of a small plastic tube which contained a message that invited anyone who captured the fish to call a telephone number and indicate the place and date it was caught.
In the project, 30,000 migratory fish were tagged between 2010 and 2015, and, thanks to it, the precise migrating routes of many species are now known. The results presented here are a result of the association between the group of icthyology of the Universidad de Antioquia and the ISAGEN hydroelectric company.

THE FLOOD PULSE. **BEATS OF THE WATER**

Wetland dynamics are linked to the beats of the water. Ecological and human activities depend on a sacred pulse, the beat to which nature forges life –second by second, century after century–.

Wetlands do not remain in the same conditions all the time; these ecosystems are characterized by expansion and contraction patterns that provide them with a dynamic behavior. Thus, it is natural and even necessary to respect their times of change and the connections between each of their habitats. The ecological processes, the reproduction and migration of many animals, and the blooming and fructification of riparian vegetation depend on the connectivity between the bodies of water.

This pulsating activity was described by Wolfang Junk and colleagues in 1989 in The Flood Pulse Concept. In this integrative vision, the authors postulate the importance of the flood pulse by evidencing that autochthonous primary productivity of flooded areas is the fundamental energy source for the entire function of the river system. This contrasts with the River Continuum Concept, postulated by Vannotte and colleagues in 1980, according to which the energy of fluvial systems comes from the importation of allochthonous organic matter (external to the system).

In tropical rivers, both these processes can be present, that is to say, the energy can come from both allochthonous and autochthonous (from the system itself) material, with variations that depend on specific conditions of each of the basin's regions. For example, the flood pulse of the Lower Atrato River basin brings a great amount of allochthonous energy to the system. These floods can cover great land extensions and the inhabitants of these bodies of water display specific behaviors for each moment of the flood pulse.

Flood pulse in the Lower Atrato River basin

HIGH WATERS

- Maximum flooding level. Marginal flooding areas. Broad connection between rivers and *ciénagas* (swamps) through the streams.
- Resident fish as well as migratory fish take advantage of flooded riparian forests in order to feed on a great amount of resources.
- Blooming season for plants such as adult *arracachos (Montrichardia arborescens)* and *cativos (Prioria copaifera),* which serve as shelter for fish.
- Manatees *(Trichechus manatus)* in mating and breeding season in the *ciénagas* (swamps).
- Fishing activity in all habitats of the *ciénaga* (swamp) complex, including marginal forests. The high water level favors aquatic transport between all of these zones.

NTERMEDIATE WATERS

- Intermediate flooding level. Marginal areas in filling or emptying processes. Connection between some *ciénagas* (swamps) and rivers.
- Initiation of the sexual maturity season for migratory species such as the *bocachico (Prochilodus magdalenae)* that leave from the *ciénagas* (swamps) to the rivers.
- Germination season and seedling sprouting of *arracachos* and *cativos.*
- Manatees use streams to move between *ciénagas* (swamps) and rivers, whether through upstream or downstream waters.
- Fishing activity in *ciénagas* (swamps) and streams. The use of marginal areas that have been dried for crops begins.

LOW WATERS

- Minimum flooding level. Dry marginal areas. Practically inexistent connection between *ciénagas* (swamps) and rivers.
- Migratory fish return to the rivers in search of appropriate spawning sites. Resident fish such as the *mocholo (Hoplias malabaricus)* remain in the *ciénagas* (swamps).
- Seed production season for *arracachos,* which provide food and shelter for mammals and birds. Fruiting season for *cativos.*
- Feeding season and movement in rivers for adult manatees.
- Fishing activity only in permanently flooded areas. Use of fertilized soil for crops such as plantain, rice, and watermelon due to the months of flooding.

AMPHIBIAN **USES**

The essence of wetlands is manifested in many everyday objects of an amphibian inhabitant. Food, shelter, utensils, and apparel are some of the innumerable expressions of the knowledge, appropriation, and transformation of the biological richness of these animals.

In the Andean region, we can observe the handcrafted use of wetland materials: *junco (Juncus* sp.) 1 to make woven mats with the stems 2 as well as baskets 3, *enea (Typha latifolia)* to weave baskets with the leaves 4, basket made with *mimbre (Salix viminalis)* 5, basket weaving technique 6, and baskets made with *cañabrava (Arundo donax)* 7. Clay is also used to make pots and dishes for serving meals 8.

As in any other ecosystem, the inhabitants of these wetlands have learned to live in balance with them. Water is clearly the immediate use of these ecosystems. In addition to its uptake, it is natural for such a present element to be a central axis in all physical and symbolic dimensions of amphibian cultures.

Plant fibers, leaves, and seeds that grow in wetlands can be used for different purposes: from the elaboration of artifacts for fishing activities to the preparation of foods such as the *canangucho chicha* drink made in the Amazon. Likewise, fish meat and meat from other animals in these ecosystems are used to cook plates such as the fish *tatuco* in the Orinoco, crab soup in the Pacific, and stuffed *gamitana* in the Amazon. Clay can also be used to make pots and other ceramic forms with different uses: spiritual, decorative, and everyday uses.

The material culture of the wetlands is built and used in innumerable ways by different human groups and even by different people of the same family; for example, in many river cultures, women and children employ hooks and fish traps for fishing near the houses, and men manipulate trammels and cast nets in deeper waters.

Throughout the country, different specialized handcrafted techniques can be found based on raw material obtained from wetlands. Basket weaving for high mountain marketing and house rooftops in the Amazon are two examples that illustrate the deep relation that communities of the amphibian Colombia establish with these valuable ecosystems.

In the Amazon, we can observe the use of various palms, for example, the *mil pesos* palm *(Oenocarpus bataua)* 1, whose leaves are used for house rooftops 2 and basket weaving 3. Another example is the use of *canangucho* palm *(Mauritia flexuosa)* fruit 4 to make *chicha* 5 and other refreshing drinks. Additionally, fishing provides food to the communities 6, and is the axis for the elaboration and perfection of fishing tools, such as bows, arrows, fish traps, and fish hooks 7, some of these are also elaborated from the stems of the *mil pesos* palm.

5

Canangucho *chicha* drink

(Mauritia flexuosa)

The multiple uses of the *canangucho* palm, emblematic of the Amazon, include the consumption of its fruit, which is rich in protein, fat, and carbohydrates, extraction of its oil, and consumption of its tender stem. One of the most traditional preparations in this region is the *chicha* drink made with this fruit, known for its high nutritional value.

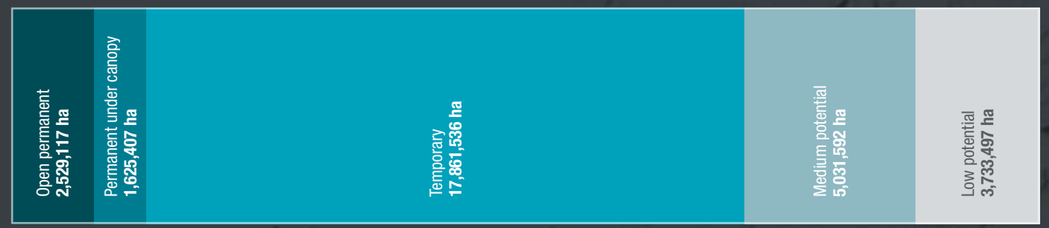
Ingredients
500 g (two cups) of *canangucho* fruits
250 g (one cup) of *panela* (unrefined whole cane sugar)
4 liters of water.

Preparation
Soak the fruits in water during one hour, peel, and remove the central seed. Blend the fruit pulp in water and drain. Mix with the *panela* and store in a clay pot or jar. Leave to ferment during 24 hours in a dark and cool place.

COLOMBIA AND ITS **AMPHIBIAN NATURE**

Water is the essence of life: our planet and bodies are fundamentally formed of this element, and Colombia is a striking example of this natural order. This map of the country's wetlands is an expression, if not the most essential, of its ecosystem richness, the closest we have to a hydric radiography of this amphibian Colombia

Identified extension per wetland category



Wetland area per hydrographic area

In recent years, Colombia –and a good part of the world– has attained a greater conscience of water use and management. The evermore frequent floods and evident impact of human activity on ecosystems have brought with them an eager to better understand the dynamics and nature of our water resources, among them, wetlands: with time, the idea was established, otherwise true, that being able to count on a reliable, exhaustive, and updated cartography of the dynamics and nature of wetlands in the territory allows more accurate measures to be implemented towards its maintenance, conservation, and management.

For this reason, in the last decades, various initiatives were carried out in order to elaborate a national wetlands cartography. Among these, the maps of Rodrigo Marin of 1992 (2,649,312 hectares of wetlands), Luis Germán Naranjo of 1997 (26,422,367 hectares), and the map of 1998, elaborated by the Humboldt Institute and the Ministry of Environment at the time, which served as a baseline for formulating the national wetland policy, can be highlighted.

Subsequently, in 2013, the year in which the *Fondo Adaptación* (Adaptation Fund) convoked the Humboldt Institute, the Instituto de Hidrología, Meteorología y Estudios Ambientales (Institute of Hydrology, Metrology, and Environmental Studies) (IDEAM), the Instituto Geográfico Agustín Codazzi (Agustín Codazzi Geographic Institute) (IGAC), and the Ministry of Environment and Sustainable Development (MADS for its initials in Spanish), Colombia could count on the first cartography that integrally reflected the wetland dynamics.

The map shows, at a scale of 1:100,000, the continental wetlands of Colombia. These ecosystems were grouped into categories that were determined by shared characteristics of their spatial and temporal dynamics:

- **Open permanent.** Wetlands where water presence is constant and there is no tree cover. For example: lakes, lagoons, *ciénagas* (swamps), rivers, glaciers, etc.
- **Permanent under canopy.** These are always flooded and have forest cover. For example: Atrato River swamps or mangroves.
- **Temporary.** Water mirrors presence is not constant, althought it presents a certain periodicity.
- **Potential.** Soil and/or landform characteristics indicate the presence of a wetland, although no flooding has been detected during the analyzed period (2007-2011). This category must be specified at scales with greater detail.

The map results are distributed among the hydrographic areas of Colombia: Amazon, Caribbean, Magdalena-Cauca, Orinoco, and Pacific.

30,781,149 ha

of wetlands

26%

of the Colombian mainland and insular territories

METHODOLOGY.

AN INTERWEAVING OF STORIES

A map is, in a way, a tale, a narration that gathers natural and dynamic processes that date from many years ago. In particular, the map of wetlands of Colombia tells a story of a country, whose terrestrial shapes, waters, soil, and vegetation compose different chapters of a same amphibian narrative.

Criteria and spatial identification process

After reviewing the processes for wetland identification carried out in other countries and consulting the available bibliography, criteria were defined for wetland identification. These were analyzed with experts in various disciplines, whose contributions enriched the initial proposal and allowed a wetland definition to be built according to the project's objective: "Ecosystems that, due to geomorphological and hydrological conditions, allows the temporary or permanent accumulation of water and give place to a characteristic soil type and/or to organisms adapted to these conditions".

Identification criteria were established and consolidated in spatial variables: geomorphology, hydrology (drainage network and flood frequencies), soils, and vegetation cover. With this in mind, the existing maps of each criterion were analyzed and processed in relation to their wetland association level. Therefore, the wetlands map of Colombia is the result of comparing, assembling, and articulating five different maps: giving rise to the notion of the map as a tale; in this case, as the unification of five tales that interweave, each one with its own special characteristics and its particular tone.

AMPHIBIAN COLOMBIA

GEOMORPHOLOGY.
THE EARTH'S TESTIMONY

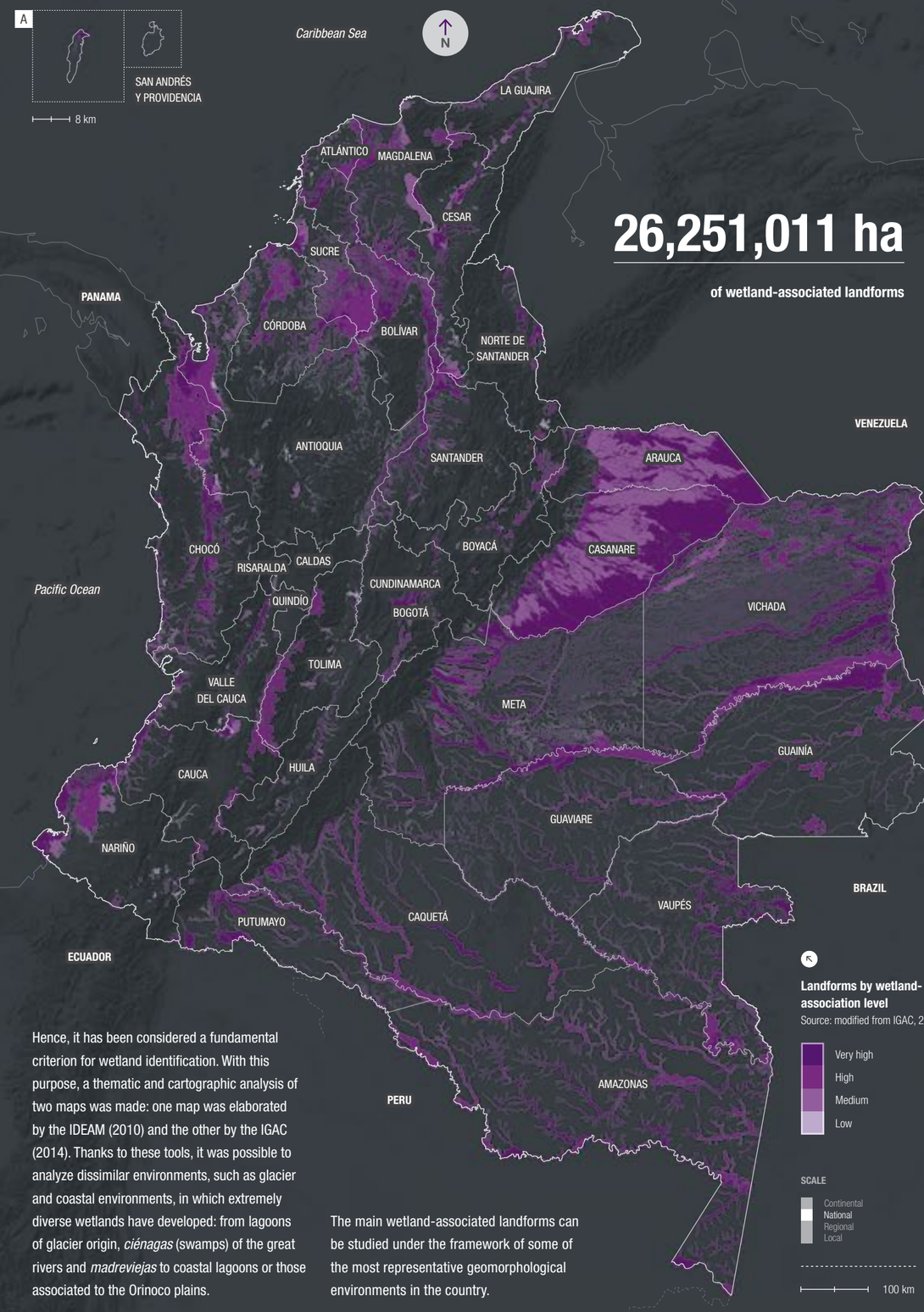
Our natural surrounding is the testimony of the passing of water and time: its landscapes and landforms are the Earth's words, an ancestral language that, in detail, narrates the history of the wetlands and bears witness to the amphibian essence of Colombia.

Landforms by wetland association level

Great system	System	Environment	Landscape type
Coastal	Littoral	Fluvio-marine littoral	
		Marine littoral	
Interior	High mountain	Glacier (current and inherited)	
	Mid and low mountain	Highplains and lakes in sedimentation processes	
		Mountain	
	Plain	Tectonic depression	
		Plain	
Artificial			

Wetland-associated landforms

A good starting point for detecting wetlands consists of recognizing the landscape characteristics that allow the permanent or temporary accumulation of water, such as the terrain's slope or curvature. This information can be understood in detail based on geomorphology concepts and methods, the science that identifies and classifies the Earth's forms, their genesis and dynamics.



26,251,011 ha

of wetland-associated landforms

Landforms by wetland-association level
Source: modified from IGAC, 2014b.

- Very high
- High
- Medium
- Low

SCALE
Continental
National
Regional
Local
100 km

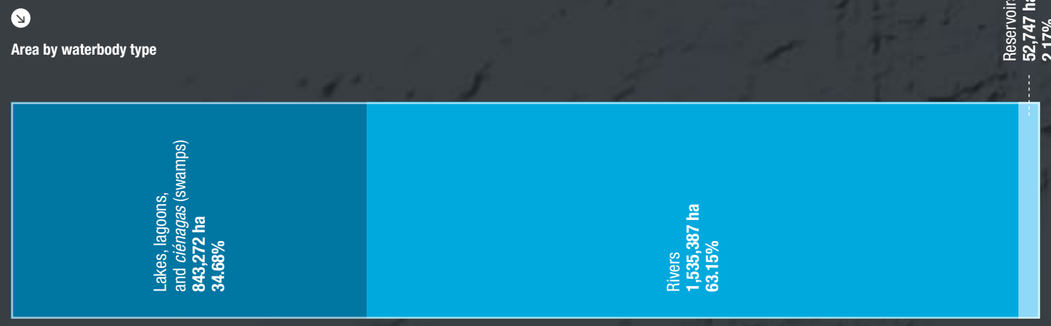
Hence, it has been considered a fundamental criterion for wetland identification. With this purpose, a thematic and cartographic analysis of two maps was made: one map was elaborated by the IDEAM (2010) and the other by the IGAC (2014). Thanks to these tools, it was possible to analyze dissimilar environments, such as glacier and coastal environments, in which extremely diverse wetlands have developed: from lagoons of glacier origin, *ciénagas* (swamps) of the great rivers and *madreviejas* to coastal lagoons or those associated to the Orinoco plains.

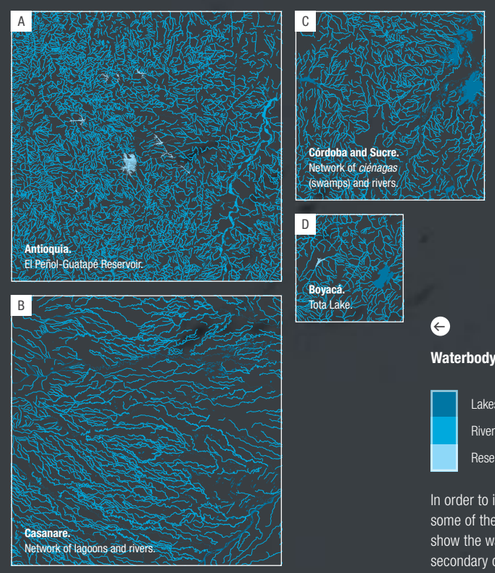
The main wetland-associated landforms can be studied under the framework of some of the most representative geomorphological environments in the country.

STORIES TOLD BY WATER. **THE DRAINAGE NETWORK**

The story narrated by the water is sinuous and laberynthic: this is a result of it being, not a simple narrative, but a convergence of endless tales that, interconnected, collide in a powerful amphibian language.

Area by waterbody type





Waterbody types

- Lakes, lagoons, and *ciénagas* (swamps)
- Rivers
- Reservoirs

In order to illustrate the water richness of some of the country's areas, the windows show the waterbodies and the main and secondary drainages.

The first great component of the hydrological criterion is the drainage network. This map identifies water-defined bodies, in other words, zones in which there is always water. This involves, for example, rivers greater than 50 m wide, lagoons, reservoirs, and *ciénagas* (swamps), among others. For this tool, we counted on previous studies from the IGAC and the IDEAM, which were consolidated to generate a new layer of cartography and were complemented through satellite images interpretation and digitalization. As a result, a map of the drainage network at the national level was obtained with integrity according to the scale.

This map is relevant in that it shows the superficial connectivity between the different wetlands, a fundamental attribute in order to understand water regulation of wetlands in the rainy season as well as the dry season. Furthermore, it shows how waterbodies vary according to the landscape, terrain structure, and even geology: for example, while small lagoons and peatlands *(turberas)* are commonly found in high mountain zones, in low lands, there is a greater presence of *ciénagas* (swamps), flooding savannas, and coastal lagoons.

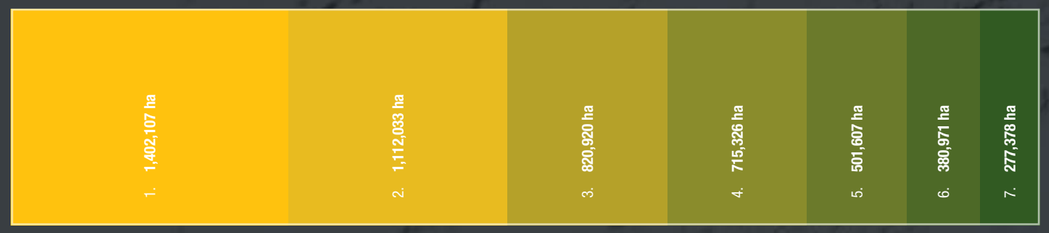
STORIES TOLD BY WATER. **FLOOD FREQUENCIES**

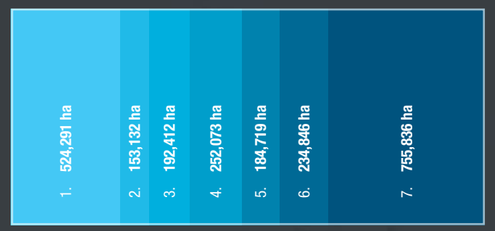
Colombia is alive, enriched by water. Wetlands beat like any heart. Expansions and contractions of water… everywhere… Respecting their pulses preserves our diversity.

5,210,341 ha

of under canopy floods

Area by frequency of under canopy floods





2,297,310 ha

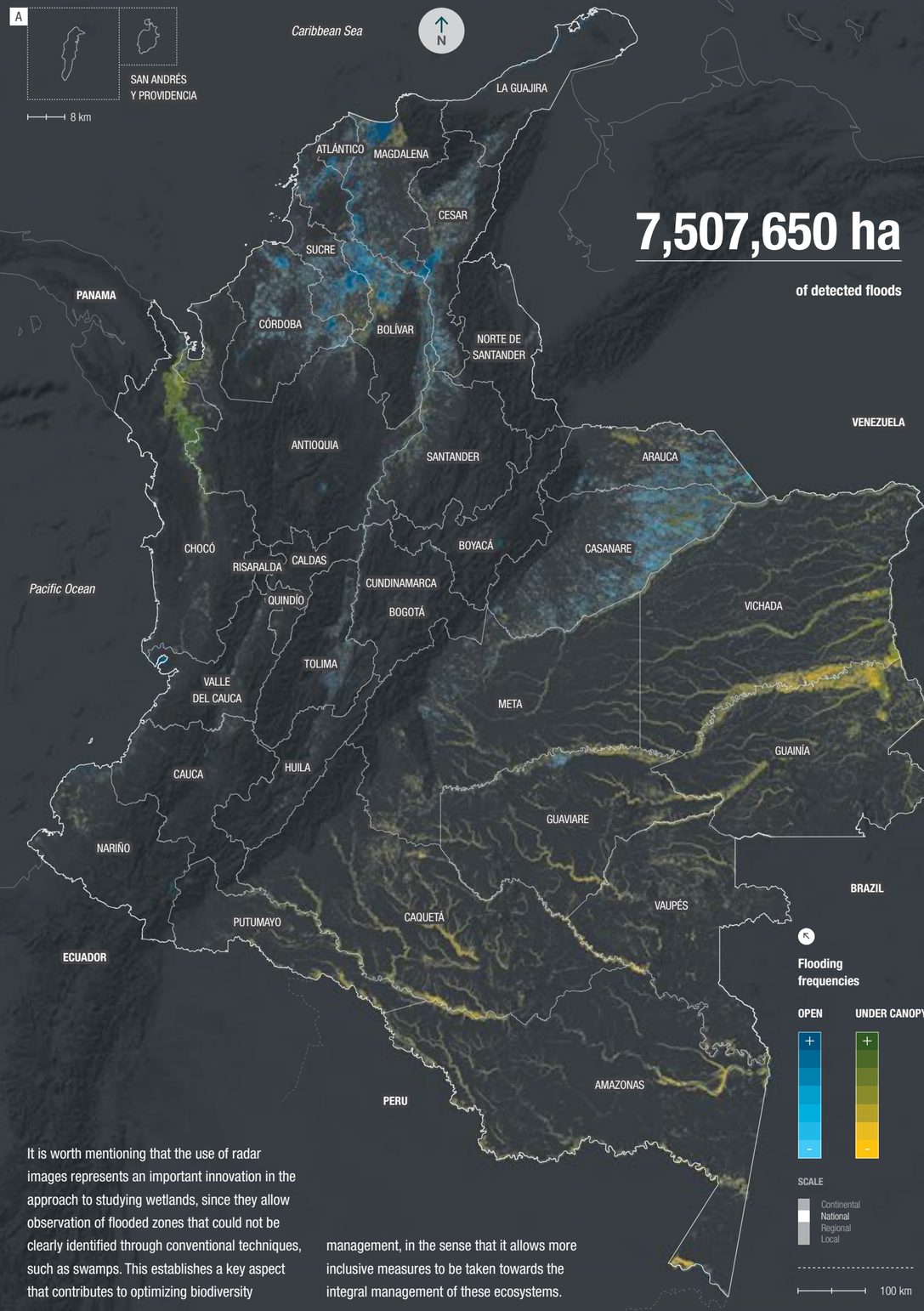
of open floods

Area by frequency of open floods

This flood frequency map was built based on the analysis of 7 flood maps classified from a time series of the Alos PALSAR FB-HH Radar mosaics of the continental Colombias, between 2007 and 2011 at 50m resolution. The study period includes both year of El Niño - La Niña events, in which maximum and minimum flood pulses are included regarding this mapas a Flood Baseline map for the country.

This map was used as one of the inputs for the definition of the wetlands Map of the whole country. It presents two main classes that are technically very well detected by radar remote sensing: 1) Flood under the canopy and 2) Open flood. In addition, the legend shows a range of frequencies for each of these two classes. Each frequency indicates the number of times one specific pixel was detected as flooded. The accuracy of the map, was done using recent developed remote sensing methodologies and was calculated on 92%.

As a result 69% of the detected inundated territories correspond to the Open flood class, while the 30% correspond to the Flood under the canopy class. The significant percentage of the Flood under the Canopy class, revels for the first time, that there are large territories inundated under the forest canopy that should be included into integral wetland management plans.



7,507,650 ha

of detected floods

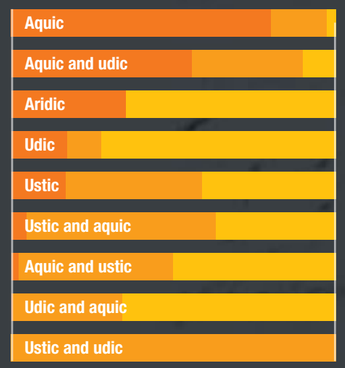
It is worth mentioning that the use of radar images represents an important innovation in the approach to studying wetlands, since they allow observation of flooded zones that could not be clearly identified through conventional techniques, such as swamps. This establishes a key aspect that contributes to optimizing biodiversity management, in the sense that it allows more inclusive measures to be taken towards the integral management of these ecosystems.

AMPHIBIAN COLOMBIA

SOILS.
THE WATER'S LOGBOOK

Soils are the Earth's memory: they are water's watchful narrators, faithful witnesses to its movements. Their testimony allows us to reconstruct our amphibian history and comprehend, as a whole, the legacy we leave as we go by.

Soil area by degree of wetland-association



The values refer to the total soil percentage for each identified water regime at the national level. The area that corresponds to each water regime varies widely. For example, aquic and udic soils correspond to 39%, while ustic and udic soils to 0.2%.

Water regime by degree of wetland-association

An important characteristic of wetland-associated soils is that they are a memory of wetlands. In fact, although the ecosystem has lost its natural cover and has been transformed, by studying the soil we can determine the presence of a wetland. On the other hand, through soils, we can also determine the temporary nature of floods, in other words, detect which soils, for example, flood for more than 40 days a year and generate the conditions of a wetland.

Based on taxonomic and variable criteria, such as water regime, natural drainage, and presence of stains in soil profiles, four types of wetland-associated soils were identified:

- **Aquic.** Soil with abundant water and low oxygen. Iron and manganese mobilization leaves greyish, bluish, and greenish spots in the profile.
- **Udic.** It occurs in regions in which water scarcity lasts for no more than 90 days a year.
- **Ustic.** In this case, water scarcity can last between 90 and 180 days a year.
- **Aridic.** Humidity conditions only reach a maximum of 45 days a year.

By including a great amount of data and evaluations, soil studies involve a considerable complexity. However, the level of detail in these analyses contributes a robust technical support to wetland identification.

22,634,262 ha

of wetland-associated soils

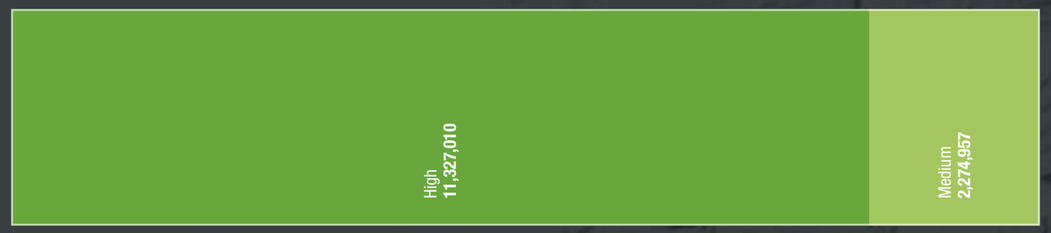
It is important to mention that not all surfaces can be considered soil, since this type of support must have had a sufficient degree of evolution in order to develop horizons and living organisms. For this reason, other types of wetland supports are also referenced: rocky and sediment, where organic matter is arranged in layers, but does not have any degree of evolution.

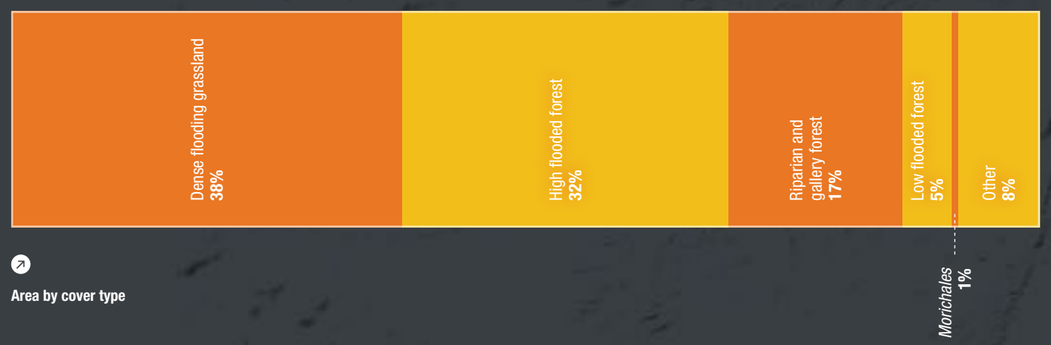
Further, consolidated wetland soils are known for their high degree of hydromorphism. This occurs due to the lack of oxygen caused by flooding and biological activity.

COVER.
AN ECOLOGICAL VOICE

The different human activities and natural processes that take place on the Earth's surface leave trails that settle, one on top of the other, like layers. One of these is the vegetation, an inevitable expression of water that embodies the last narrative link: the final and literally living chapter of the amphibian tale.

Area by degree of wetland-association



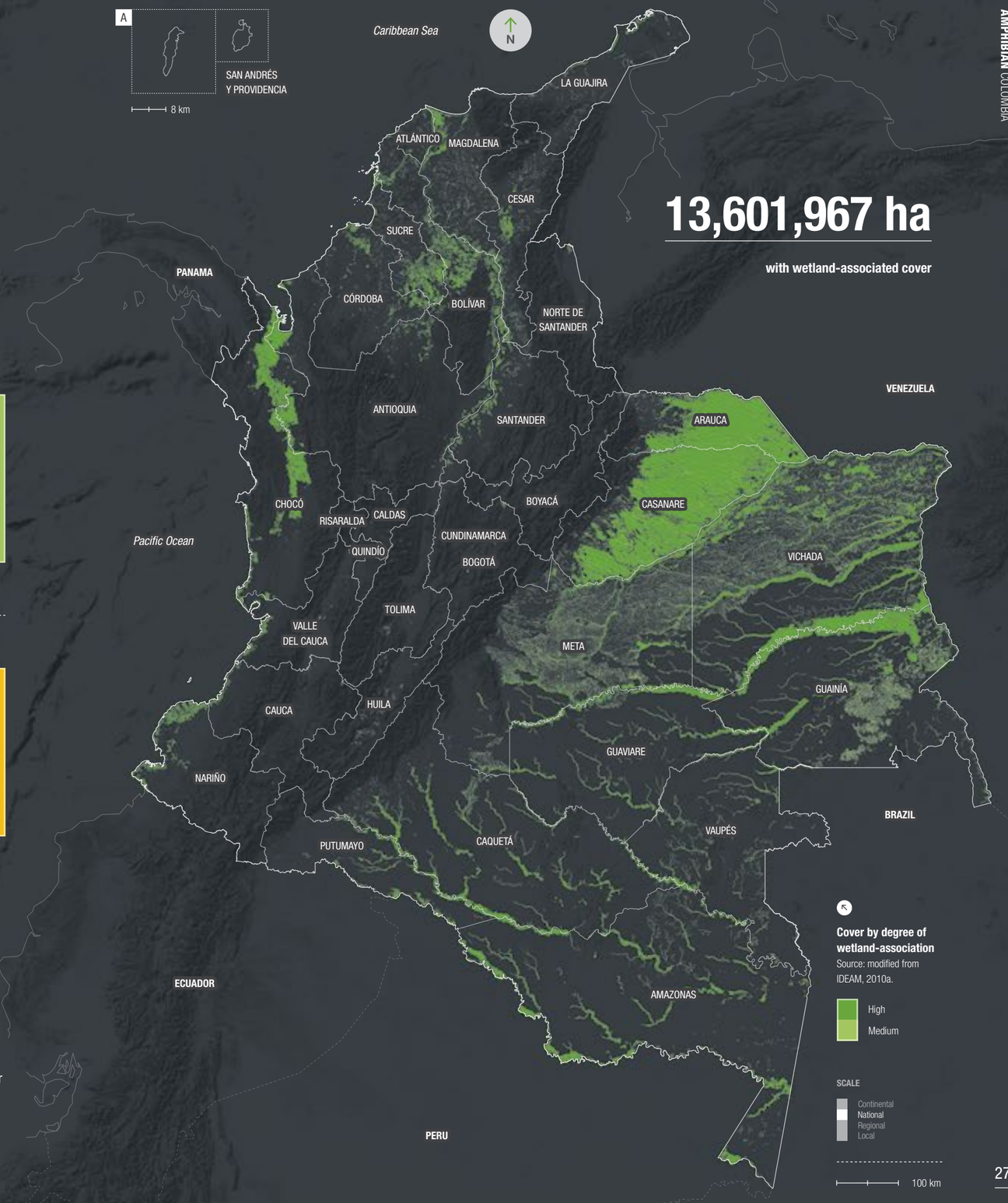


Area by cover type

Cover incorporates wetland-associated mappable elements at a scale of 1:100,000, mainly vegetation and other Earth covers such as:

- Shrublands, grasslands (open, dense)
- Flooded forests (dense, high, low).
- Riparian and gallery forest.
- Sandbanks.
- Hypersaline areas or salt flats.
- Peatlands.
- Swamps
- Glacier zones and *nevados* or snow-covered peaks.

Thus, cover and vegetation in particular are strong references in order to understand wetland behavior and its nature. If, for example, a plant community that can grow under flooded conditions is found, it is a clear indication of the presence of a wetland. The following illustrates wetland vegetation cover in regions and some specific types of vegetation.



WETLANDS OF THE **HIGH MOUNTAIN**

In lagoons of the páramo, the language of the wetlands reaches great heights. The majestic flight of the condor, the emblematic spectacled bear, and the campesinos of the páramos of Colombia are just some of the expressions of life linked to these delicate wetlands.

The high mountain wetlands (peatlands, marshes, and lagoons) can be located over 3000 m.a.s.l. and are characterized, among other aspects, by having flora and fauna adapted to low temperatures and high evapotranspiration. The dominating vegetation can be very varied; the communities of the terrestrial-aquatic interphase vary from mosses to vascular plants resistant to decomposition.

These ecosystems are very sensitive to climate change and are currently exposed to multiple interventions by human activities. One of the main threat factors to these wetlands is water regime alteration and the use of wetland areas for different anthropic practices.

Location of the high mountain wetlands

Paramo lagoon

1

***Campesinos* of the paramo.** "We are inhabitants of the páramo, born and raised here, we are *campesinos* who love our land; we all have *ruana,* some have *sombrero, machete,* and *bordón* (staff)" (inhabitants of the Cundiboyacense Highplains).

2

Shrub and herbaceous vegetation. They provide shelter and food to the fauna. Among other species, we can find the *frailejón (Espeletia frailejon), guardarrocío (Hypericum mexicanum),* cranesbill of the páramo (*Geranium sibbaldioides), quiche de agua (Paepalanthus pilosus), chochitos* or lupins *(Lupinus bogotensis), chusques* or evergreen bamboos *(Chusquea tessellata), guasgüin (Diplostephium cinerascens),* and *cucharo (Myrsine guianensis).*

3

Mammals. The white-tailed deer *(Odocoileus virginianus)* and the spectacled bear *(Tremarctos ornatus)* are charismatic mammals that are characterized by having broad habitat requirements and for being umbrella species. The Andean bear feeds on plants such as the *puya* and *chusque,* or evergreen bamboo. The deer feeds mainly on tender shoots of plants of the High Andean forest.

4

Birds. The Andean condor *(Vultur gryphus)* is a scavenger bird. It can live over 30 years and fly up to 5000 m.a.s.l. The green-bearded helmetcrest *(Oxypogon guerinii)* is a hummingbird common to high mountain habitats, particularly, paramo and subparamo. It has a strong association with frailejones and can be found up to 5200 m.a.s.l.

AMPHIBIAN COLOMBIA

WETLANDS OF THE **PACIFIC COAST**

A splendid spectrum of species unfolds around the wetlands of the Pacific. This great fertility blooms in the confluence between freshwater and saltwater, taking advantage of tidal behavior.

In the dense forests of the Colombian Pacific littoral, freshwater from the rivers mixes with saltwater from the sea. The daily dynamics of these ecosystems, in which close to 300,000 hectares of mangroves exist, are determined by a tidal change twice day. These mangroves can reach great heights and provide a home for many fish, both marine and freshwater fish, in their juvenile stages. Thus, these wetlands function as exporters of matter and energy to other ecosystems. They also harbor many species of flora and fauna.

Location of the Pacific Coast wetlands

Mangrove

1

Piangüeras. Women dedicated to *"conchar"* or "shelling", an activity that consists of collecting *piangua (Anadara tuberculosa* and *Anadara similis),* bivalve species that inhabit mangrove roots.

2

Lagarto saltaarroyos* or common basilisk *(Basiliscus basiliscus). It lives in wetland margins and has the ability to run on the water surface.

3

Blue crab *(Cardisoma crassum).* It inhabits mangrove roots. It builds its burrows in areas closest to the terrestrial vegetation.

4

Fish. The *gualajo* or snooks *(Centropomus armatus)* (A) stays in the mangrove as a juvenile, and when it is an adult it moves to the neighboring estuaries. Other species, such as the *tamborero* or pufferfish *(Spheroides rosenblatti)* (B), can remain in the mangrove their entire lives.

5

Salamanqueja* or yellow-headed gecko *(Gonatodes albogularis). Excelente climbers. They are territorial.

6

Mangroves. Plants with morphological and physiological properties that allow them to adapt to the water salinity, low oxygen content of flooded soils, and substrate instability. For example, the red mangrove *(Rhizophora mangle)* (A) presents prop roots, and the *nato* mangrove *(Mora oleifera)* (B) has tabular roots.

7

Water oppossum *(Chironectes minimus).* It lives in forests associated to bodies of water. It is an excellent swimmer. Carnivore, it feeds on fish, crustaceans, frogs, and fruits.

8

Ringed tree boa *(Corallus annulatus).* Tree snake common in mangroves.

9

Naidizal. Wetland dominated by the *naidí* palm *(Euterpe oleracea).* This species can withstand prolonged flooding periods and produces a fruit highly desired by local inhabitants.

10

Neotropic cormorant *(Phalacrocorax brazilianus).* It always lives in places near water. It feeds on fish, tadpoles, and aquatic insects.

In the midst of an endless list of resources, ranging from newspapers, movies, and magazines to the computer, Internet, and E-books, the printed book must function under a new logic that we have perfected and that the editorial team of this publication has strongly embraced.

In consequence, we have produced a work that tries to adjust to its time by presenting its content in an agile and eloquent manner, supported primarily by visual resources. The result is a different way of displaying information, through an aesthetic notion that guided decisions such as the slightly different application of certain cartographic conventions and the use of infographics. Moreover, the double-page structure allows a fragmented reading, akin to the specific needs of each reader.

The reading of this text comprises four levels: a first level title, with an almost poetic approximation to the importance of the wetlands; a second more suggestive level, where the reader is offered an introduction to the page's content; a third level in which more precise terms are used and natural phenomena are defined with greater precision; and, finally, a fourth level where the technical nature of certain necessary visual elements or concepts is described in order to express the scientific structure that nourishes the wetland experience.

We hope that this effort, accomplished alongside the editors, the entire team at the Institute and its collaborators, achieves its final purpose: to portray the magnificence of our wetlands through a reading experience that rises to the occasion and conveys them in all their glory.

.Puntoaparte
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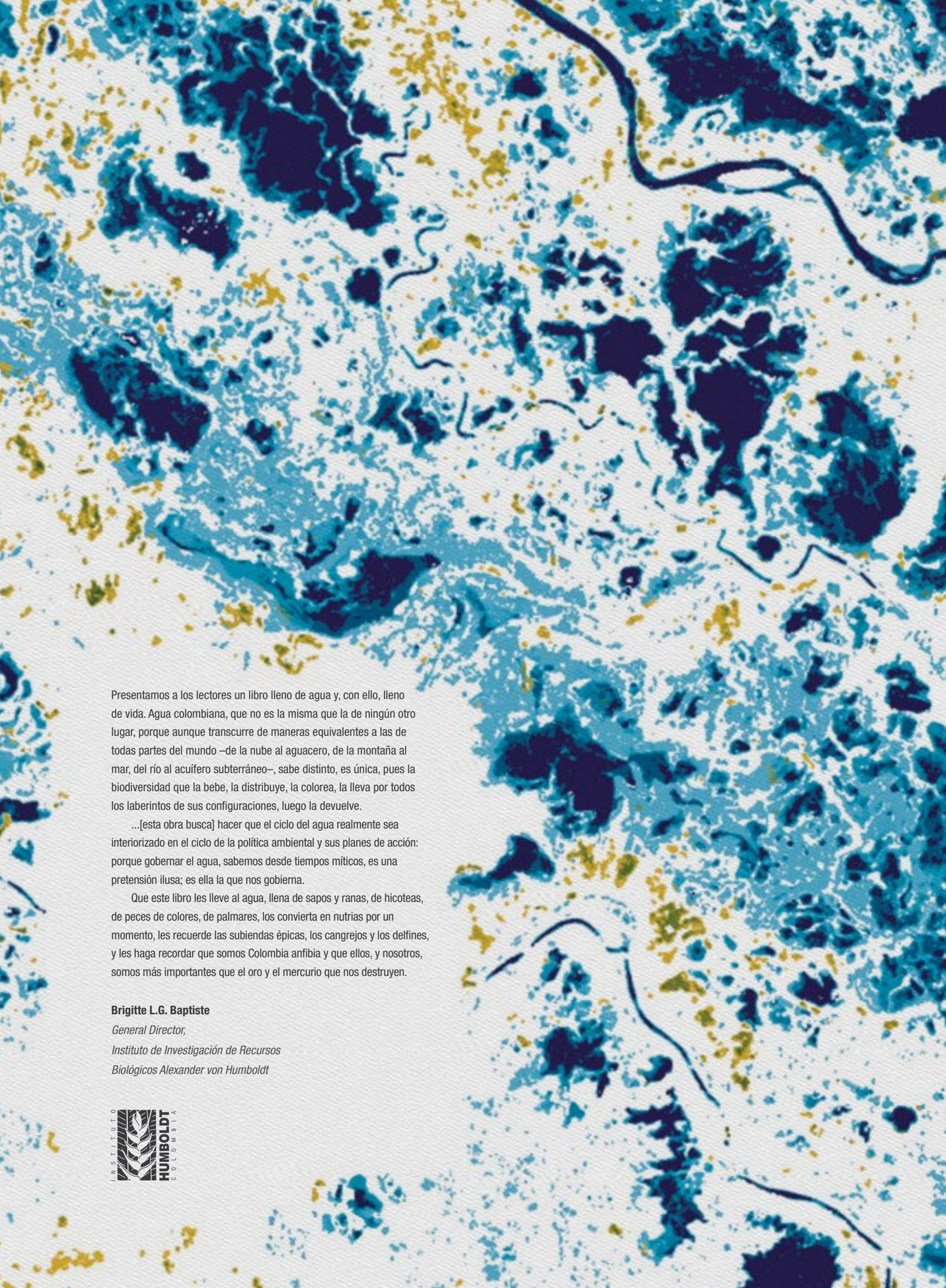

Presentamos a los lectores un libro lleno de agua y, con ello, lleno de vida. Agua colombiana, que no es la misma que la de ningún otro lugar, porque aunque transcurre de maneras equivalentes a las de todas partes del mundo –de la nube al aguacero, de la montaña al mar, del río al acuífero subterráneo–, sabe distinto, es única, pues la biodiversidad que la bebe, la distribuye, la colorea, la lleva por todos los laberintos de sus configuraciones, luego la devuelve.

...[esta obra busca] hacer que el ciclo del agua realmente sea interiorizado en el ciclo de la política ambiental y sus planes de acción: porque gobernar el agua, sabemos desde tiempos míticos, es una pretensión ilusa; es ella la que nos gobierna.

Que este libro les lleve al agua, llena de sapos y ranas, de hicoteas, de peces de colores, de palmares, los convierta en nutrias por un momento, les recuerde las subiendas épicas, los cangrejos y los delfines, y les haga recordar que somos Colombia anfibia y que ellos, y nosotros, somos más importantes que el oro y el mercurio que nos destruyen.

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