

# Compounded crises, investments, and future land use change in the Pantanal

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## 1. Introduction

The year 2020 will be remembered for a pandemic that took the world by surprise, disrupting every aspect of human life across the globe. This crisis of global proportions was compounded by the increasingly visible impacts of another one: global warming. The year 2020 broke multiple climate records, from widespread heat waves (Overland and Wang, 2020) to raging wildfires (Muniz et al., 2020) and unprecedented droughts (“Severe drought,” 2020). While several factors played into these climatic events, there is no doubt that global warming worsened them (Borunda, 2020). Both crises are poised to have significant impacts on land systems (Mishra et al., 2021). Food supply chains were severely disrupted by the pandemic, with the closure of borders, immobilization of the labour force, and changing consumption patterns (Hobbs, 2020; Torero, 2020). Deforestation appears to have spiked amidst reduced capacity for legal enforcement (Branca et al., 2020). Over 2,500 major fires were detected in the Amazon basin in 2020, many linked to deforestation for agriculture (Finer et al., 2020). Wildfires also charred over 4 million acres in California (Asanjan et al., 2020), with consequences for conservation, tourism, and urban development. Meanwhile, the United Nations Department of Economic and Social Affairs is expecting massive setbacks on SDG progress across multiple indicators due to the pandemic (Min and Perucci, 2020).

These compounded crises could have lasting effects on land systems worldwide. The COVID pandemic alone has already inspired discourses of transformation across multiple domains, either as an inevitable outcome of the crisis, or as a necessary response to it (e.g., Castro et al., 2020; Lew et al., 2020; Webb et al., 2020). Together with climate extremes, it has generated a great amount of uncertainty about what the world will look like in the near future. The land-use literature has highlighted the importance of shocks or “punctuated change” in triggering sudden, unexpected changes in land systems, or “regime shifts” (Müller et al., 2014). In Vietnam, for example, a transition

away from shifting cultivation was driven by abrupt policy change (Müller et al., 2014), while the plummeting of anchovy catches in 1972 under a strong El Niño event played a key role in the rise of soybeans in the Brazilian Cerrado (Ramankutty and Coomes, 2016), and the collapse of the Soviet Union triggered widespread land abandonment in Eastern Europe (Prishchepov et al., 2012). The year 2020's multiple concurrent crises could similarly push some land systems over thresholds that will lead to irreversible change.

In this paper, we explore the potential effects of compounded crises – the COVID pandemic, an extreme fire season, an unprecedented drought, and a reduction in the flow of the Paraguay river not seen in fifty years – on future investments and land-use trajectories in the Pantanal, a wetland region spanning across parts of Brazil, Bolivia and Paraguay. We ask whether there are any signs that these crises will push the Pantanal in new directions, and what these might mean for the conservation of this important ecoregion. The Pantanal, a major global hotspot of biodiversity, currently faces multiple sustainability challenges, several of which are linked to the main land use activities present in the area, such as cattle ranching and mining (Tomas et al., 2019). Understanding how land uses might evolve in the future is therefore crucial for future conservation planning (Iwamura et al., 2018).

To do so, we use a combination of information sources. We analyze reports from public agencies including municipalities, ministries as well as some NGO and independent organizations to understand land use and investment trends prior to the crises. We complete these with a series of unstructured interviews with key informants selected to represent the main sectors at stake and revolving around impacts of and responses to these crises. Interviews were conducted in Spanish and Portuguese over phone or videoconference by the authors between September and December 2020. We conducted a total of 53 interviews, of which 22 with public officials (in ministries of

transport, economic development offices, regional tourism offices, and regional agricultural offices) and 31 key informants from the private sector (farmers and ranchers, agroindustry, tourism, mining, infrastructure/construction, and representatives of the navigation sector; see Table 1). Finally, we tracked recent local news articles throughout the region relating to investments in infrastructure and to the impacts of these compounded crises.

	Public sector	Private sector
Mato Grosso do Sul, Brazil	8	10
Mato Grosso, Brazil	5	8
Bolivia	7	8
Paraguay	2	5
<b>Total</b>	<b>22</b>	<b>31</b>

*Table 1. Breakdown of interviews.*

## 2. Territorial organization, development and conservation in the Pantanal

The Pantanal is a wetland ecosystem spreading over approximately 210.000 km<sup>2</sup> across Brazil, Bolivia and Paraguay (WWF-Brazil, 2021), in which the seasonality of flood and drought governs the interactions between fauna and flora, as well as production processes. The region has long been home to multiple indigenous groups, including the Kadwéu, Terena, Bororo and Gautó in Brazil (Chamorro and Combès, 2015), the Chiquitanos and Ayoreos in Bolivia (Díez, Astete, 2018), and the Ayoreos, Ybytosó or Yshyro, and Tomaráho in Paraguay (DGEEC, 2004). These groups have engaged to a varying degree with central states and settler society. Ayoreos, for example, had scant contact with Spanish colonization until the 20th century, while the Chiquitanos were integrated early on into Jesuitic missions. Many now live on titled indigenous land in Brazil (567 titled territories (FUNAI, 2021)), Bolivia (two titled territories totalling 1.2 million hectares (Paye et al 2010)), and

Paraguay (a dozen titled territories totalling ~60,000 ha (<https://www.tierrasindigenas.org/>)), although some also live outside these territories. Livelihood activities within these groups include fishing, hunting, family agriculture, livestock herding, as well as in some cases, the provision of labour for extractive activities such as mining (Fundación Tierra 2011) and casual labor on farms (Blaser 2010).

With a population of under a million people (about half a million in Brazil, 75,000 in Bolivia, and 17,000 in Paraguay (Instituto Nacional de Estadística 2020a), the Pantanal is a highly peripheral territory within each of the three countries it covers. Its integration into national economies is still ongoing, particularly in Bolivia and Paraguay, where it remains relatively inaccessible. Its economic significance is largely tied to the role of the Paraguay river, which serves as the core structural axis for communications and the transportation of goods to and from the Brazilian state of Mato Grosso do Sul in Brazil and the department of Santa Cruz in Bolivia. As a result, the main human settlements in the region are located along the Paraguay river. In fact, nearly all important cities in the Pantanal are port cities.

In Brazil, Paraguay River has not been very important for the export of the product, until 2017, only 0.6% left by this means, mainly soybeans (Tosi, 2019). In Bolivia twenty percent of the country's total exports, mainly soybeans and derivatives, leave through the Pantanal, by way of the Paraguay River (Instituto Nacional de Estadística, 2020). The Pantanal's ports are connected by rail and highway to the city of Santa Cruz, at the core of Bolivia's booming agricultural frontiers and gateway to the rest of the country. This makes the main port in the region, Puerto Quijarro, particularly important for Bolivia, which has made improvements to port infrastructure and to the navigability of the upper Paraguay river a priority for the region. Although the river has also been an important artery for Paraguay, this is particularly true of the lower portion of the river - much of the rather limited production of the Paraguayan portion of the Pantanal is currently exported by road.

The role of the Pantanal as point of exit and transit zone is reflected in recent investments in the area. Investments in ports, roads and waterways over the last couple of decades reached a total of US\$ 106 million in Mato Grosso, US\$ 2.9 billion in Mato Grosso do Sul, US\$1.3 bn in Paraguay and US\$ 1.8 bn in Bolivia. Meanwhile, transportation was the largest recipient of public investment in the Pantanal after the gas pipeline linking Bolivia and Brazil. Further investments were planned for the integration of the region through the completion of the *corredor bioceánico*, a major road axis meant to link the two coasts, and which traverses the area at the level of Porto Murtinho in Brazil and Carmelo Peralta in Paraguay.

These investments in fluvial and road transportation, and the prospect of more such investments in the future, have caused concern among environmentalists for several reasons. First, the dredging of the river, which is necessary to improve its navigability, can change its hydrology (Wetlands International 2019). Second, improvements in accessibility are likely to support the development of agricultural frontiers and intensification of agricultural land uses, at the expense of forests and natural grasslands. While interviewees in Mato Grosso do Sul believed that livestock farming has reached its maximum expansion point, the production of grains, essentially soybeans and corn, presents a new expansion potential as logistical conditions improve.

	Bolivia	Paraguay	Brasil
Railway	700.000.000	x	x
Roads	649.647.000	1.641.286.400	648545578,2
Plants	x	x	x
Ports	450.000.000	5.000.000	4635427
Basic Maintenance	x	x	x
Waterways	10.500.000	x	400455591
Thermoelectricity	x	x	x
Slaughterhouses	x	x	x
Bridges	x	169.072.000	x
urban infrastructure	x	x	x
Gazoducts	x	x	2.000.000.000
Export infrastructure	x	x	2764037,556

*Table 2: Significant investments by sector, in US\$. The absence of numbers does not indicate complete absence of investment, but rather, the absence of major, recent investments.*

Cattle ranching has existed for over two hundred years in the Brazilian Pantanal, and it remains the central economic activity in the region (Ribeiro, 2015), with an estimated XX heads of cattle across the territory (24.3 million in Mato Grosso, 19.4 million in Mato Grosso do Sul, for a total of over 44 million in Brazil, 360,000 in Bolivia, and 1.8 millones in Paraguay (Senacsa, Estadística 2020, Sistema Integrado de Información Productiva, 2017, IBGE, Censo Agropecuario 2017)). Originally conducted over natural grasslands only, cattle ranching increasingly involves the replacement of native grasses by exotic ones, which allows to intensify production. Today, ranching in the Brazilian Pantanal is no longer a low-labour, extensive activity but is largely done with modern techniques by highly-trained professionals in order to match the quality standards demanded by world markets. Paraguay arrived to a similar situation of large cattle ranches on exotic pastures not through the intensification of an extensive grazing model, but through the expansion of large cattle ranches from the Chaco into the Pantanal over the last couple of decades. In Bolivia, large ranches have also appeared in or near the Pantanal over the same period. Meanwhile, expansion and intensification were supported by some investments in supply chain infrastructure, particularly slaughterhouses. While there have been few such investments in Brazil (indeed, a Marfrig slaughterhouse in Porto Murtinho was even closed recently), in Paraguay new 20-million-dollar slaughterhouse is being discussed, which would probably be built around Bahia Negra. The spatial expansion of cattle ranching in all three countries has been accompanied by the clearing of native forest and brush - in the Bolivian Pantanal, for example, about 11,000 hectares are deforested annually, most of it for pastures (Andersen & Ledezma, 2019, Mendez) This has raised concern among environmentalists.

Croplands are not as prevalent within the Pantanal plain itself, because it offers unfavourable conditions for most mechanized crops except in some non-flooded areas contiguous with the Pantanal. There is however some amount of small-scale family farming, particularly in Bolivia, where a small area of rice and corn is cultivated in the Pantanal, mostly within indigenous territories the Pantanal (Sistema Integrado de Información Productiva, 2019). Large-scale commercial agriculture does exist, however, on the margins of the Pantanal plain. In Brazil, there is significant soybean production on the plateau immediately adjoining the Pantanal, with over 10 million hectares of soybeans cultivated only in the state of Mato Grosso. In Paraguay, some ranchers have started experimenting with soybeans as well in areas close to the Bolivian border, which offer good conditions for agriculture, but the logistics of getting commodities out to market remain a challenge. In line with the limited role of croplands, there was also relatively little private or public investment in agricultural supply chains in the area.

Another core activity for the Pantanal is mining, which is conducted in elevated outcropping rising out of the Pantanal plain. The southern part of the Pantanal has one of the largest reserves of iron ore and manganese in Brazil, which responsible for a significant portion of the country's exports. Multiple gold mines are also located on the border the Pantanal around the town of Poconé. In Bolivia, mining is concentrated around the Precambrian shield, with the extraction of iron, gold, precious stones, manganese, and limestone. Currently, this activity employs less than three thousand people, but there are wide expectations about its future expansion (Municipio de Puerto Suárez). One significant recent development in Bolivia is the opening of the Mutún iron mine, financed by the Bolivian government (at an estimated cost of US\$ 423 million as of 2020) and operated originally by an Indian company, and more recently by the Chinese Sinosteel Equipment & Engineering. Mining activities do not directly compete for space with ranching of agriculture given their small



spatial footprint, but they have been a sour point for conservation and the tourism industry, since they release pollutants in the Pantanal's waters, with consequences for aquatic ecosystems, and hence also recreational fishing.

Indeed, tourism is an increasingly important activity in the region. Developed in the 1970s and 1980s, particularly for fishing and wildlife sighting, it attracts national and international visitors to its inns, fishing grounds, hotel boats and campsites, which managed by staff trained to meet demanding standards. Tourism aimed at the observation of the landscape, birds and even catch-and-release fishing, is an economic activity that does not generate significant pressure on natural resources. As such, it is closely associated with conservation initiatives. Well established in Brazil, tourism is however only nascent in Bolivia and all but absent in the Paraguayan Pantanal.

### 3. Crises, impacts, and responses

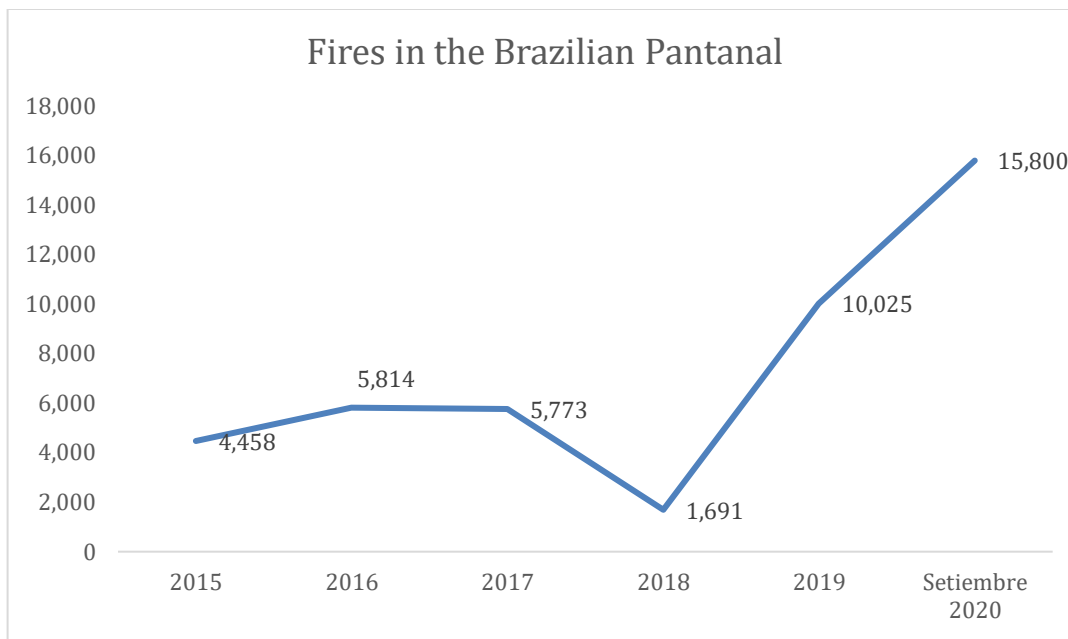
#### *3.1. Crises*

During the year 2020, four crises jointly affected, with different levels of intensity, the natural resources, society and economy of the Pantanal. The first was the COVID-19 pandemic, which hit all three countries that share the Pantanal severely. At the beginning of 2021, Brazil had accumulated 8.3 million infected and 207,000 dead, while Bolivia had 153,000 infected and more than 9,500 dead, and Paraguay counted 120,000 infected and 2,400 dead. While there are no statistics at the level of the Pantanal, the region was hit as hard as the rest of the country, with indigenous communities being particularly affected. In addition to the cost in lives, the pandemic was accompanied with restrictions on international and internal travel across the three countries.

The second crisis that hit the region was an unprecedented drought, the worst observed in about fifty years (Marengo et al. 2016), which severely impacted primary production in the region. Rainfall in the area totalled 350 mm between the months of November 2019 to March 2020, considered the rainy season in the Pantanal, or 43% of the expected for the historical average less than in recent years (EMBRAPA, 2020).

Third, massive forest and grassland fires that burned through the Pantanal, affecting mainly the Brazilian portion of the ecoregion. Over 4.1 million hectares of land burned in Brazil, or 30% of the total area (LASA 2020). Another 174,000 and 83,000 hectares burned in Bolivia and Paraguay, respectively (Fundación Amigos de la Naturaleza, 2020). These fires were often set by ranchers as a way to manage woody encroachment on pastures and clear woodlands for expansion (ref.). However, under exceptionally dry conditions, fires this year frequently spun out of control, so that the area burnt ended up amounting to 3 times the average in recent years (INPE, 2021). Fire

also destroyed more than ten wooden bridges, which are essential to road transportation in the Brazilian part of the Pantanal (Agesul, 2020).



*Figure 1: Forest in the Pantanal (source: Instituto Nacional de Pesquisas Espaciais (Brazil))*

A fourth crisis, also associated with the drought, was the dwindling of the Paraguay river for lack of rainfall. While river levels typically fluctuate with the seasonal pulse of the Pantanal wetland, this year was exceptional in that respect, too. The flow of the most important waterway of the region was reduced to levels not seen in half a century, almost drying up completely in places. Water in the Tamengo canal in Puerto Quijarro, Bolivia, dropped to 1.5 meters depth, making navigation impossible in the main exit route to the Paraguay river and the Atlantic for Bolivia. The last drought of similar magnitude occurred in the late 1960s and 1970s and similarly had led to the closure of Bolivian ports in Puerto Suárez due to navigation difficulties (De Marchi et al., 2020). The depth of the Paraguay river in the city of Ladário in Brazil reached 29 centimeters, compared to 3 meters in normal years (Dias, 2020); in Asunción, Paraguay, it reached a low of 54 centimeters. Because most

ships using the waterway to transport goods need at least 1.8 meters depth to operate, this greatly limited the river's navigability and profoundly disrupted the transportation of commodities produced in the Brazilian and Bolivian Pantanal.



*Figure 1: Impacts of the four crises: a burnt bridge in the Brazilian Pantanal, low levels of the Pilcomayo; dry pastures; and distribution of medical supplies during the COVID pandemic.*

### *3.2 Impacts*

These four simultaneous crises affected the Pantanal in complex and sometimes ambiguous ways. Here, we review these impacts in planned by sector.

Cattle ranching was greatly affected by the drought and fires, particularly in Brazil. Uncontrolled fires killed some animals while the drought forced some ranchers to move their herds in order to access sufficient feed, and the reduction of the availability of pasture affected the profitability of ranching operations. Additionally, in Brazil, the destruction of wooden bridges by wildfires cut many ranches off from markets. These joint shocks hit a sector that was already undergoing important transformations, with a gradual decrease in the breeding stock which, due to low market prices, the owners had already been selling, culminating in the decrease in cattle for slaughter. The shock was felt less in Bolivia, where the impacts of the fires were less intense and the exportation of the products of ranching does not depend on wooden bridges. Meanwhile, the fear that consumers would turn away from beef consumption due to economic hardship and a decrease in restaurant visits in the wake of the pandemic, leading to a price drop, did not materialize. In fact, beef prices increased significantly in this period (Canal Rural, 2021), due in part to the ravages of the African swine fever epidemic, which greatly reduced the availability of pork meat, leading consumers, and particularly China, to turn to beef (Smyth et al., 2020). In summary, the fires affected the livestock in two ways. The first was the burning of pastures, which resulted in a reduction in food for the animals. The second, even more serious, was the impossibility of moving the cattle to areas with pastures or to slaughterhouses, due to the burning of at least ten bridges.

Crop farming, though relatively marginal within the Pantanal itself, is prominent in its surroundings. The low levels of the Paraguay river significantly increased the cost of transporting agricultural commodities out to markets - transport costs increased by 25% according to one estimate (Instituto Boliviano de Comercio Exterior, 2017). Farmers were forced to send grains by truck to the Atlantic. The smallholder agriculture sector in Bolivia within the Pantanal suffered heavily from the impacts of drought and fires. In the National Protected Area of San Matías in Bolivia, where the

majority of indigenous Chiquitanos of the Pantanal live, 11,989 hectares were burned in 2020, directly affecting their subsistence crops (Centro de Estudios Jurídicos e Investigación Social 2020).

Mining, another key economic sector in the Pantanal, was similarly affected by the low navigability of the Paraguay river, which significantly increased the cost of exporting ore. In Brazil, for example, ore that would normally be exported through the waterway had to be transported by truck. The transport capacity of a barge is 200 tons; about 170 trucks are needed to transport as much (G1 Globo, 2020). This therefore generated massive cost overruns for this sector. Additionally, the pandemic impacted briefly increased the demand for and price of gold, considered a refuge commodity. According to interviewees with knowledge of the mining industry, however, this spike was offset by increased operation costs in pandemic times and did not last. The price of iron ore also increased dramatically since the pandemic (<https://markets.businessinsider.com>), which may have positive impacts on mines such as Mutún, in Bolivia, which just started operations (Ministerio de Minería y Metalurgia, 2020).

The forest industry was severely impacted by wildfires. First, a significant percentage of the timber stock was destroyed. In Bolivia, over 34,400 hectares of forest cover were burnt in the Pantanal region (Flores-Valencia & Maillard, 2021). In Brazil, 4,117,000 hectares of woodlands were reduced to ashes. Second, the wildfires sent operation costs for forestry companies through the roof (Noleedi, 2020), as an important share of resources were spent on controlling and mitigating the spread of fire. In addition to that, interviewees working in the forestry sector in Bolivia reported that the economic downturn associated with the pandemic translated into reduced demand for timber on the national market, particularly in the second quarter of 2020 (Instituto Nacional de Estadística, 2020b).

Finally, tourism suffered devastating consequences from both wildfires and pandemic. The COVID-19 pandemic disrupted both international and national travel, leading for example to a drop of 90% in the number of visitors in the part of the Pantanal located in the state of Mato Grosso (Soares, 2020). While pandemic-related travel restrictions are likely the single most shock factor for tourism, wildfires have also burnt through multiple conservation areas, and decimated wildlife, potentially reducing the attractiveness of the Pantanal to wildlife tourists for some time. Ashes from the wildfires have also caused a deterioration of water quality, with impacts on leisure fishing, though these are likely to be resorbed relatively rapidly. Additionally, summer fires and travel restrictions were immediately followed by the *piracema*, a period of restricted fishing extending from November to February to allow for fish reproduction, meaning that recreational fishing could not resume in 2020 (Ribeiro, 2015). Prospects for recovery in the next years are grim for the tourism industry, as it will depend not only on getting the pandemic under control, but on the willingness and financial ability of people to travel - the Ministry of tourism expects a recovery by 2024-2025 (Folha, 2020).

Altogether, these four crises had an impact on the logic of investments driving each of the main economic sectors. Investments were re-planned and reorganized to recover and provide a renewed impulse to each activity. Nearly all planned investments in the livestock, tourism, mining and public policy sectors were reformulated. In the case of Brazil, the Federal and State Governments launched programs aimed at accelerating the recovery of economically important sectors, such as livestock, through the construction and replacement of burned wooden bridges with concrete bridges. In other sectors, such as tourism, investments were either canceled or suspended until the conditions of the local, national and global context become stable and predictable again. Public investments were in their majority already planned, but they had to be redirected, at least in the Brazilian Pantanal, not

only to prioritize investment in concrete bridges, but also to support other social measures to mitigate the losses incurred from the pandemic.

### *3.3. Responses*

Responses to these crises ranged from measures aimed at the management of short-term recovery to efforts aimed at strengthening the local economy and mitigating the impacts of future crises. Here, we look at responses that may have implications for land use in the medium term in the region.

**Short-term alleviation.** Significant resources were put towards supporting struggling economic sectors through the year. In Brazil, the Emergency Plan for the Recovery of Pantanal Cattle Ranching (Plano Emergencial de Recuperação da Pecuária Pantaneira), focuses on resources for the recovery of productive infrastructure such as fences and corrals burned by fires. It is estimated that for the year 2021, the Constitutional Fund for Financing the Central West will allocate more than 33 million dollars, for both Brazilian wetland states (Anonymous, 2020a). The tourism industry, which brings together hotels, boats, guides, service providers and fishing materials, is receiving government assistance that guarantees minimum income for workers, which allows them to survive and financial support for tourist companies with the Tourism Fund (FUNDTUR, 2020). In Paraguay, there were no specific measures for the Pantanal portion. In Bolivia, the government has attempted to relaunch tourism, especially domestic (Ministerio de Desarrollo Productivo, 2020), but the Pantanal is not a priority destination.

**Medium-term recovery and reconstruction.** Governments have vowed to use agricultural investments as a path to economic recovery after the pandemic, for example, new credit lines for soy and livestock producers (Governo MS). In Bolivia, dormant mining projects have been reactivated,



in addition to those already in existence (precious stones in Rincón del Tigre, iron in Mutún, limestone in Yacuses or gold in neighboring Chiquitanos municipalities). Among these is a private project for the exploitation of manganese in the San Matías protected area, which had been discussed over a decade ago and which now appears to have received an exploitation and clearing permit.

**Mitigating the impacts of future crises.** The low navigability of the Paraguay river in 2020 brought home the importance of that logistic hub for the region – even if the river levels were restored relatively soon, losses were irremediable. In the wake of the crisis, dormant efforts to improve the waterway’s navigability were reactivated. Puerto Quijarro and the Tamengo canal have long been considered a bottleneck in Bolivia’s export infrastructure, and there have been talks of circumventing it by creating a new port in Puerto Busch, a small outpost in the middle of the Pantanal. This distant dream was revived this year, with very concrete plans to achieve it. The year 2020 saw progress in the form of the establishment of electricity infrastructure and satellite connections, as well as a new law addressing the operation of Puerto Busch and the Paraguay - Paraná Waterway through the organization of a stakeholder alliance (Aduana Nacional, 2020; Administración de Servicios Portuarios, 2020). Additionally, this prompted some ports to innovate in order to mitigate the impacts of changing water levels (<http://www.puertojenifer.com.bo>). Across the three countries (and further downstream in Argentina), there were calls to more consistently dredge the river (Anonymous, 2020b). Additionally, in Brazil, public and private agencies mobilized to install fire brigades in the interior of the Pantanal, offer specialized training to firefighting and prevention teams, equip the brigadiers, buy air tractor model airplanes, increase the number of inspectors to find and punish arsonists, invest in satellite technology to monitor fire outbreaks, among other improvements.

**Opportunistic changes.** Finally, the COVID pandemic monopolized media attention during much of 2020. This provided opportunities for interest groups to push for reduced enforcement of environmental regulations, particularly in Brazil, where some farmers took advantage of the situation to clear land illegally (Nugent, 2020), but also in Bolivia, where new legislations favourable to GMO were passed by the interim government (Molina, 2020) - although these had to do more with crop varieties that are cultivated on dry land, and thus were not directly relevant to the Pantanal.

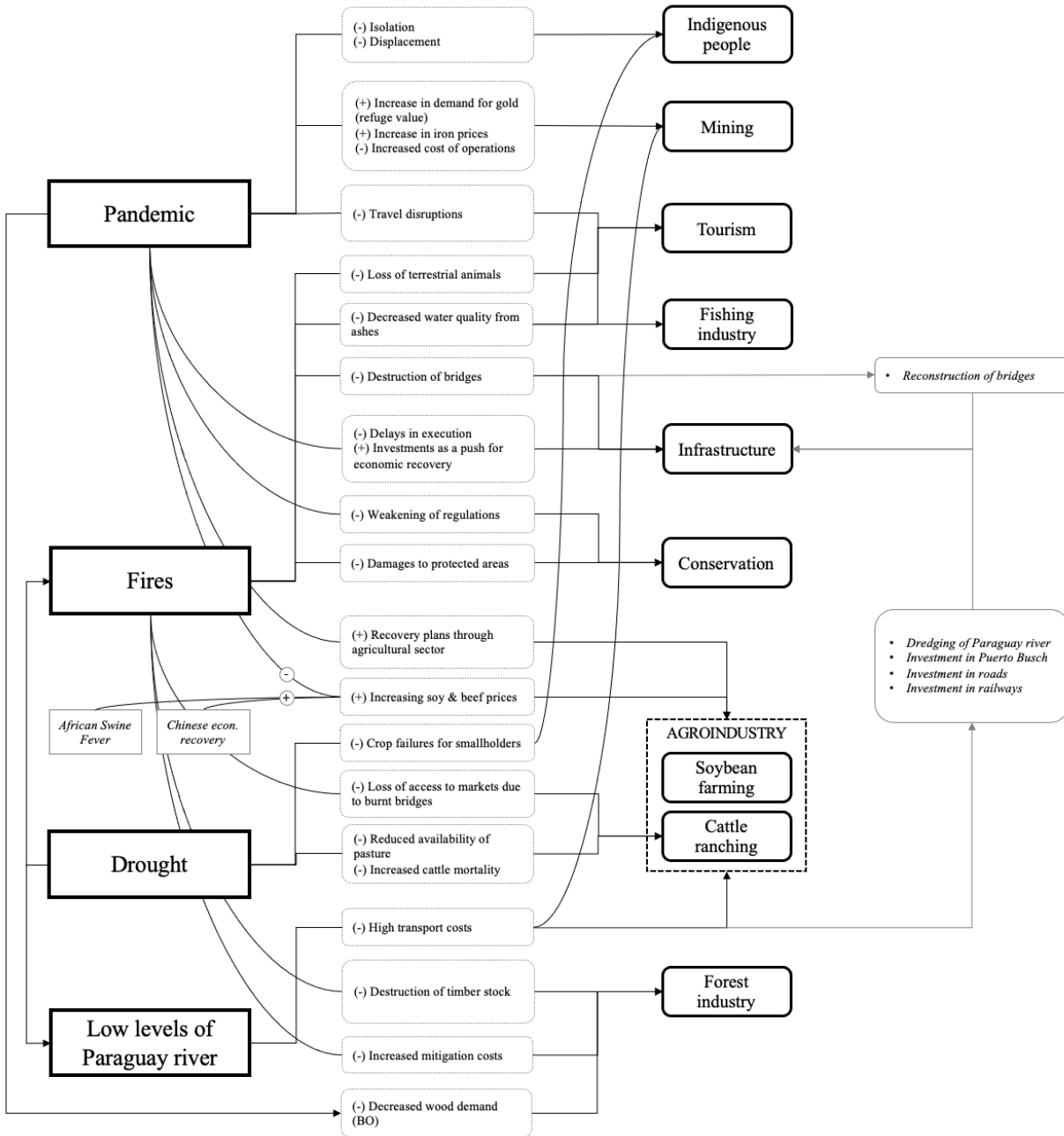


Figure 2.: Summary view of relations between crises, impacts and responses.

#### 4. Future trends and environmental prospects

Our exploration of the impacts of four simultaneous crises in the Pantanal shows that they have been sufficient to shake the economy significantly. Here, we propose a few trends that we see potentially emerging, and discuss their implications for environmental conservation.

*Cattle ranching may take a “green” road to recovery, particularly in Brazil.* Forest fires will have a relatively short residual effect on natural resources, due to the capacity for biological regeneration of the wetlands, but the result will put greater pressure on agricultural and livestock producers, due to the fact that schemes that promote an environmental organization and imply more actions and resources to the management of fires as well as other natural attributes, especially in the Brazilian portion, where the intensity of fires has been greater. In addition, increased international visibility and greater awareness of this ecosystem will likely generate greater international pressure for the protection of the biome. The losses caused in the livestock facilities and infrastructure will have impact this production system’s profitability due to the new expenses incurred in rebuilding the fences, corrals and bridges. In Brazil, this situation means a likely relative decline in livestock production in the states of Mato Grosso and Mato Grosso do Sul, compared to the other Brazilian producing regions. If we add to this the uncertainty in the world meat market, this time also associated with the pandemic, it is very likely that efforts to add natural and sustainable attributes to the livestock production of these regions will be accelerated, as a strategy of maintenance and conquest of markets. This may be an opportunity for the sector to incorporate better production practices that include elements of sustainability in cattle ranching, as well as better infrastructure to prevent and mitigate future forest fires.

*Tourism may take several years to recover and may take a permanent hit.* The scenario for the tourism sector, almost exclusively based and practiced in the Brazilian Pantanal, is one of relatively rapid recovery of the natural environment from forest fires, and relatively rapid but expensive rebuilding of destroyed infrastructure. However, based on the guidelines of the biosafety measures of the World Health Organization - WHO and the training of Brazilian public agencies for businessmen and workers in the tourist activity, the sector will only slowly resume its activities. Great uncertainty remains about the possibility of other waves of contagion, and thus about the need to continue precautionary measures against the proliferation of the virus, even with the application of the vaccine. In the Pantanal, as well as in different parts of the world, a new profile of consumption of tourism experiences has emerged, with a search for more local or regional destinations and a preference for trips closer to their homes, with difficulties and / or prohibitions to make international trips. both entering and leaving Brazil and readaptation to the new reality.

*Under international scrutiny, countries will amp up efforts to monitor and control fires in the Pantanal.* The international visibility that the fires have brought to the region means that all eyes are now on the Pantanal and the Amazon. This means there are some prospects for changes in the direction and conduct of Brazilian environmental policies. International pressure for a strict policy to combat deforestation and environmental control will lead government and private companies to adapt to the conditions proposed by the World Trade Organization - WTO (Economia.estadao.com.br/), lest Brazil be left with a very restricted market for the export of commodities, to the advantage of other countries that are part of the global environmental protection agreements. These pressures may, to a lesser extent, apply to Bolivia and Paraguay, but interviews suggest that they may be balanced out by strong agricultural and ranching interests and relatively weak environmental enforcement.

*Labour may move out of family farming and into mining in Bolivia.* Smallholder communities in and around the Pantanal were severely affected by the crises described above. Meanwhile, the Bolivian government has an interest in generating income through the sale of raw materials such as gas and minerals. Together, this will likely lead to continued growth of the mining sector, which will create new jobs in mining that some local smallholders will take, given the better economic prospects offered by these jobs over smallholder agriculture. Such a movement is already being observed in the area. This may have consequences over the way indigenous and non-indigenous smallholders use their territories in the Bolivian Pantanal, potentially leading to some land abandonment.

*Infrastructure projects to improve the reliability of fluvial transportation on the Paraguay-Paraná waterway and reinforce the logistical integration of the area will be made a priority.* The low levels of the waterway showed the three countries what the costs of low navigability in the area could be. This was particularly concerning for Bolivia, which depends on the waterway for its exports from the region, including of the growing mining industry. The operation of the Mutún iron mine requires good navigability on the Paraguay-Paraná waterway, preferably via an exit in Puerto Busch, which would bypass some of the most problematic areas of the waterway. This will accelerate development plans in that port. It is also very likely that the governments of Bolivia and Paraguay will advance and intensify the dredging tasks in the most problematic points to ensure navigability. This has consequences beyond mining. Soybean farmers across the area, particularly in Bolivia, have expressed great interest for an exit through Puerto Busch. Additionally, the deployment of regional integration projects, such as the bi-oceanic corridor and the bridge between Carmelo Peralta (Paraguay) and Porto Murtinho (Brazil) will be mobilized to build back local and regional economies. Ultimately, the combination of the completion of the bi-oceanic corridor and

improvements to the Paraguay-Paraná waterway will probably incentivize the conversion of land to croplands in suitable (non-flooded) areas of the Pantanal.

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