Appendix 4. SELS Descriptions by Regional Specialists

SER A. Sparsely populated southern cold lands

SELS A1. Sparsely populated cold extra-tropical Andes

It includes the coldest areas of the sub-continent (area= 27 million hectares), both mountainous dry (Puna) and humid (Patagonia) terrain (Matteucci 2012, Grau et al. 2019). The region has a very low population density, associated with limitations for human agency due to a rigorous climate, which explains why it is separated from the northern Altiplano. Traditional land uses (i.e., extensive sheep raising and marginal agriculture) are experiencing dis-intensification. Tourism, in contrast, is on the rise, with less conventional forms prevailing (e.g., ecotourism, cultural tourism). Mining has strong potential, with both ongoing active expansion (e.g. Lithium salt brines in the Puna) and socio-environmental conflicts resulting from advanced planned projects (e.g. Gold mines in Patagonia). Protected areas are extensive, widespread, and with comparatively few conflicts, but in some areas invasive species are expanding their range. Wildlife is generally in good shape and often recovering. Most of the SELS occurs along the Chilean-Argentine border, which implies some associated social dynamics (e.g. government investments associated with infrastructure, military and bureaucratic jobs, and relatively mild international conflicts during the 20th century).

SELS A2. Remote cold ecotonal extra-tropical Andes

It includes areas bordering SELS A1 to the east, in the ecotone with places at lower elevation, both in the Puna highlands and in the southern temperate forests (area=32 million hectares). Temperature and human population are low, but higher than SELS A1, and rainfall is never as high as in SELS A1. Protected areas are common, and there are relatively small but prosperous urban centers, often associated with tourism and small-scale intensive agriculture. With a more mesic environment than SELS A1, vegetation alternates grasslands, shrublands and forest woody patches. Fire is a relatively common component of ecological functioning and of human-environment relationships (Veblen et al. 1999). This region has high travel time to ports, hence qualifying as "remote".

SELS A3. Low-diversity cold and temperate grassy rangelands

Dominated by a shrub–grass steppe, with low plant diversity, low forest cover, and medium shrub cover (area= 73 million hectares). The northern part corresponds to the "Monte-Arid Chaco-Espinal" and the southern part corresponds to the "Patagonian Steppe". The climate of this region is arid and semi-arid, and cold or seasonally cold, reaching freezing temperatures throughout the region. Plant diversity is low. Human population is also low and concentrated in humid valleys with irrigated agriculture. The rural inhabitants depend mainly on livestock grazing, such as sheep and goats. Overgrazing has led these systems to show signs of desertification, which intensifies the low productivity in the region (Jobbágy and Sala 2000), including the decreasing of low-cover palatable species and increasing relative cover of unpalatable grass species (Perelman et al. 1997).

SELS A4. Low-diversity low-populated shrubby rangelands

Located at the interphase between the "Monte" and the "Patagonian steppe" (area= 29 million hectares). It includes the well-developed irrigated valleys of northern Patagonia (Negro and Colorado rivers with important production of fruits such as apple and vineyards), and the surrounding drylands. It is characterized by a high coverage of shrubs, very low population density and extensive livestock grazing (Pol et al. 2005). There is also oil exploitation and irrigated production in the valleys, favored by good access to ports (e.g. San Antonio Oeste, Madryn). The dominant vegetation is grasses, shrubs, and small scattered trees (Cabrera 1976). In addition to its biogeographical core of Southern Monte shrublands, this SELS seems to capture shrub-encroached areas elsewhere, like in the Chaco plains. This SELS has higher shrub and cattle density compared to SELS A3. These differences between both SELS are useful to highlight the dynamism of the system in the Monte-Espinal transition, as overgrazing or abundance of fires can transform a portion of SELS A3 into SELS A4.

SER B. Arid and semi-arid highlands and adjacent coast, with a long history of agriculture and mining

SELS B1. Arid and semi-arid highlands and adjacent coast, with long history of agriculture and mining

This is the only SELS integrating the homonymous SER B, which spans over the Southern and Central Andes (area= 126 million hectares). It has a cool and overall dry climate which limits agriculture to irrigated areas in valleys and coastal areas and seasonal rainfed cultivation in higher lands. This SELS ranks highest in crop diversity due to its rough geomorphology, high climatic diversity but also its ancient settlement history (before 1700) and relatively high population density (including some large cities such as Lima and Santiago). Therefore, it represents a hotspot of agro-biodiversity linked to both biological and cultural diversity (Mathez-Stiefel et al. 2012, Sietz and Feola 2016). The combination of urbanization, subsistence agriculture, seasonal rainfall and rough topography makes the highland areas very sensitive to climate change and to land use change (Ochoa-Tocachi et al. 2016, Mathez-Stiefel et al. 2017, Tito et al. 2018). The narrow semi-arid Pacific coast is characterized by export-oriented, irrigated agriculture and concentrates most of the economic and political power, especially in Peru. Overall short travel time to ports implies high influence of the overseas trade on regional processes. It ranks highest in mining density, highlighting its social-ecological impact including the ongoing and potential conflicts between extractive activities, traditional and commercial agriculture, environmental conservation and tourism (Tovar et al. 2013, Pérez-Rincón et al. 2019).

SER C. Consolidated large scale agropastoral plains

SELS C1. Urbanized large scale agricultural plains

Covers the grasslands, savannas and shrublands of Uruguay, central east Argentina, and east Paraguay, in addition to patches in south Brazil, Bolivia, Colombia and Venezuela (area= 196 million hectares). This SELS is defined by the presence of agriculture in flat sedimentary landscapes. It is dominated by highly productive rainfed agriculture (e.g. wheat, maize, soybean, sunflower) and outstanding cattle production, but also includes places with irrigated crops. There is internal heterogeneity, with gradients of anthropization levels and different histories of agricultural expansion. In general, these are densely populated areas, with the presence of large farmers and economical power concentration. Land use and land cover changes have transformed the landscape structure and dramatically altered the original vegetation cover (Baldi and Paruelo 2008, Gasparri and Grau 2009, Vallejos et al. 2015). These changes have a major impact on the provision of ecosystem services, and have also generated asymmetries in the use and access to natural resources between stakeholders.

SELS C2. Consolidation of agropastoral lands in savannas and semi-deciduous forest

Located mainly in central Brazil (e.g. Cerrado), to some extent in the llanos of Colombia and Venezuela, the Pantanal, and areas of recent deforestation in western Brazil and in the Chaco (Bolivia, Argentina and Paraguay) (area= 280 million hectares). This SELS is characterized by regions that are flat, hot, with intermediate rainfall, low to intermediate forest cover, and high grass cover. It includes large-scale agriculture (e.g. soybeans and maize) but cattle ranching is dominant, with varying population density and relatively short travel time to cities. Historic deforestation for cattle ranching and agricultural operations, and frequent fires in Central Brazil have created the savanna landscapes that we know today as the Cerrado (Banda-R et al. 2016, Nobre et al. 2016). In more recent times, similar dynamics are occurring in the frontiers between this SELS and the Amazon and Chaco regions. Many areas of SELS E2 are interspersed within this SELS, with similar conditions but more recent deforestation (Silvério et al. 2013). Areas of “natural” savannas, such as the Pantanal, Roraima, and parts of the llanos of Colombia and Venezuela have a different set of native species, but similar land use (e.g. cattle ranching). This SELS represents a transition or intermediate stage between the historical agriculture plains of SELS C1 and the new agricultural frontiers of SELS E2.

SER D. Historically populated tropical areas with low potential for mechanized agriculture

SELS D1. High density montane populations with agropastoral activity

Mainly spans the Northern Andes from northern Peru to Venezuela and to a lesser extent, the more humid eastern slope of the Central Andes (area= 65 million hectares). There is also a small sector in the Serra do Mar north of Rio de Janeiro, Brazil. This SELS is characterized by mountains, sometimes extending into neighboring coastal lowlands (e.g. Ecuador), warm and temperate temperatures, and intermediate levels of precipitation. They include a long history of human intensive land use, as precolonial civilizations occupied much of this area. This SELS includes the highest current population density of all SELS and many medium and large size cities (Parés-Ramos et al. 2013). Political instability (e.g. conflict in Colombia) with important impacts on land use (Sánchez-Cuervo and Aide 2013) is common, including the abandonment of some agricultural activities and the secondary forest recovery (Nanni et al. 2019, Aide et al. 2019). Grass, for cattle grazing, is the dominant cover, followed by trees, and crops. Important crops in the region include coffee and cacao (Rueda and Lambin 2013), and irrigation helps to support a high diversity of Andean crops. Legal and illegal coca plantations are an important feature.

SELS D2. Intensive, market-connected hilly agropastoral systems with long colonization history

It is dominantly located in hilly to partly mountainous terrain, but with excellent access to larger markets and economic hubs (area= 105 million hectares). These areas have a long history of early colonial occupation, and experienced several periods of political instability (Dean 1997, Joly et al. 2014). Land use is diverse and heterogeneous, yet agricultural systems are characteristic for this SELS, dominated by high-intensity cattle husbandry and croplands. The grassland cover is oftentimes composed of planted pasturelands. Croplands are of relative low diversity (i.e. monocultures) and include annuals (e.g., soybean, maize), perennials (e.g., coffee, orange, eucalyptus), and semi-perennials (e.g., sugar cane). Population density is among the highest on the continent, with many communities living in medium-sized cities, but also in metropolitan regions such as Sao Paulo and Rio de Janeiro. The main contiguous area is dominated by fragmented tropical rainforest corresponding to the biome “Mata Atlântica” (i.e., Atlantic Forest) in Brazil (Ribeiro et al. 2009). To the northwest of this main area still within Brazil, climate is dryer and vegetation transitions to the “Cerrado.” The most northern regions encompass parts of the Colombian and Venezuelan Llanos.

SELS D3. Highly populated and biodiverse historical semi-arid areas

Corresponds mostly to the Caatinga and some parts of the Cerrado in Eastern Brazil and includes dry valleys in the eastern slopes of the tropical-Andean valleys of Peru and

Bolivia (area= 99 million hectares). It also includes the Santa Catarina area in Southern Brazil and some portions of Central Colombia and NW Ecuador. These areas seem not to fit this description (being more rather humid areas) which is supported by the high classification uncertainty associated with some of these regions. The definition of this SELS appears to be a result of high deforestation and a long history of landscape transformation. It is characterized by a semi-arid climate with very high temperatures, a rough topography and is covered by dry forests and shrublands. This historical settlement area (before 1700) still maintains densely populated areas and has high levels of both plant and crop diversity, including irrigated agriculture.

SER E. Tropical forests with low anthropization

SELS E1. South American lowlands: new agropastoral frontiers

This SELS corresponds to agricultural frontier regions located in the flat warm lowlands of South America, and includes biomes such as the Amazon, Cerrado and Chaco (area= 183 million hectares). While this SELS is dominated by forested landscapes, some other areas include naturally open ecosystems (e.g. the Bolivian Llanos de Moxos, or the Humid Chaco ecoregions). Although the landscape is mainly dominated by natural vegetation, many areas have been subject to active land use changes throughout the past five decades (e.g. the colonization of Brazilian states of Pará, Mato Grosso, and the Argentinian East Chaco began around the 1970's along highway constructions, indicating many of these settlements have been long established and are no longer "active" frontiers). Accessibility levels are intermediate, and while the population is predominantly rural, small and medium cities are growing in importance as the service economy develops, especially in association with agricultural production. Conflicts around land use are common, involving clashes between existing populations, landless people, and new settlers and between agribusiness and subsistence agriculture (Caldas et al. 2010, Aldrich et al. 2020). These conflicts are related to vast inequities in land distribution and associated production opportunities; and an overall pressure on natural resources for the production of global commodities (Simmons et al. 2010). Thus, this is a highly dynamic SELS where some regions may currently be in transition, with an unstable equilibrium of natural landscapes affected by different land use practices (e.g. extensive cattle ranching, commodity crop production, fires), and climate change (Silvério et al. 2013, Nobre et al. 2016).

SELS E2. Remote and mountainous tropical lands

This SELS is mainly located in the very humid foothills and lower montane areas of the Amazon and Orinoco basins (area= 117 million hectares). It also includes the Guiana highlands of Venezuela, Guyana, Suriname, and Brazil, the Eastern slope of the Andes (upper Amazon in Ecuador, Perú and Bolivia), as well as a few other scattered forested highlands in Argentina, Bolivia, Brazil and Colombia. The SELS is mainly characterized by high levels of forest cover or natural vegetation; however, it also includes some agricultural land uses such as coffee and cacao plantations. It is characterized by rugged/mountainous geomorphology, and low levels of accessibility. It has the largest proportion of protected area, which includes high profile conservation areas reflecting the importance of this SELS for biodiversity and related ecosystem services. The management of many of these lands is tied to national systems of protected areas as well as widespread and vast indigenous territories (Achtenberg 2013, Rodriguez 2017). This SELS should not be mistaken with intact "wilderness". Instead, it exemplifies a Social-Ecological system where many traditional communities co-exist with conservation, tourism, forestry, and other extractive activities. These extractive activities are also relevant for SELS E3.

SELS E3. Tropical forests with low anthropogenic conversion

This SELS mainly covers the most isolated regions of the Amazon basin, plus other highly forested regions, such as the deciduous forests of northern Argentina, northern Paraguay and eastern Bolivia (area= 437 million hectares). The spatial extent of this SELS overlaps with old growth or minimally disturbed forests by post-Columbian populations (Tyukavina et al. 2016, Potapov et al. 2017). Environmental characteristics include vast, relatively flat areas often flooded, high temperatures, high precipitation, and high forest cover. Human settlements tend to be small and sparsely distributed along rivers, with low levels of accessibility by roads. Overall, this SELS has fewer anthropogenic pressures on the environment, but also lower levels of monitoring, enforcement, and governance. While some regions of this SELS do include small-scale subsistence agriculture, other land uses related to extractive activities exist, yet are difficult to detect with current remote sensing technologies, as they do not necessarily coincide with extensive land cover changes. Some of these extractive activities might include forest degradation, forest fires and burned areas, defaunation processes catalyzed by rural and indigenous communities that practice hunting or poaching (Benítez-López et al. 2019), and artisanal and small-scale alluvial artisanal and gold mining (Alvarez-Berríos and Aide 2015). In addition to these activities, changes in size and status of conservation areas also threaten environmental conditions in these areas, adding to the political and social challenges of the SELS (Alvarez-Berríos and Aide 2015).

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