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A second hydrocarbon boom threatens the Peruvian Amazon: trends, projections, and policy implications

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Abstract
The Peruvian Amazon is home to extraordinary biological and cultural diversity, and vast swaths of this mega-diverse region remain largely intact. Recent analysis indicates, however, that the rapid proliferation of oil and gas exploration zones now threatens the region's biodiversity, indigenous peoples, and wilderness areas. To better elucidate this dynamic situation, we analyzed official Peruvian government hydrocarbon information and generated a quantitative analysis of the past, present, and future of oil and gas activities in the Peruvian Amazon. We document an extensive hydrocarbon history for the region—over 104 000 km of seismic lines and 679 exploratory and production wells—highlighted by a major exploration boom in the early 1970s. We show that an unprecedented 48.6% of the Peruvian Amazon has been recently covered by oil and gas concessions, up from just 7.1% in 2003. These oil and gas concessions overlap 17.1% of the Peruvian Amazon protected area system and over half of all titled indigenous lands. Moreover, we found that up to 72% of the Peruvian Amazon has been zoned for hydrocarbon activities (concessions plus technical evaluation agreements and proposed concessions) in the past two years, and over 84% at some point during the past 40 years. We project that the recent rapid proliferation of hydrocarbon zones will lead to a second exploration boom, characterized by over 20 000 km of new seismic testing and construction of over 180 new exploratory wells in remote, intact, and sensitive forest areas. As the Peruvian Amazon oil frontier rapidly expands, we conclude that a rigorous policy debate is urgently needed in order to avoid the major environmental impacts associated with the first exploration boom of the 1970s and to minimize the social conflict that recently led to deadly encounters between indigenous protesters and government forces.

Keywords: Amazonia, Peruvian Amazon, oil development, natural gas development, indigenous peoples, protected areas

1. Introduction

The Peruvian Amazon—the second largest land area of the Amazon Basin after Brazil—is a region of extraordinary biological and cultural diversity. It is one of the most biodiverse regions on Earth for a wide range of taxa, including birds, primates, amphibians, and trees (Terborgh *et al* 1990, Puertas and Bodmer 1993, Doan and Arriaga 2002, ter Steege *et al* 2003, Pitman *et al* 2008), and still contains large, relatively contiguous areas of primary rainforest (Oliveira *et al* 2007, Nepstad *et al* 2008). The Peruvian Amazon is also

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home to around 60 distinct groups of indigenous peoples[4] (INEI 2008, INDEPA 2009), including an estimated 14 or 15 groups still living in voluntary isolation with no regular contact with the outside world (Defensoría del Pueblo 2006, Survival International 2008). This remarkable biological and cultural diversity is the basis of a relatively extensive system of 35 protected areas across the Peruvian Amazon. In addition, the Peruvian government has issued 1232 land titles to Amazonian indigenous communities and created five territorial reserves for the protection of indigenous peoples in voluntary isolation (Defensoría del Pueblo 2006, Benavides 2009).

However, much of the Peruvian Amazon, including lower-level protected areas and titled indigenous lands, is now covered by active or proposed oil and gas concessions (Finer *et al* 2008). Of all the land designations noted above, only the 13 national parks and sanctuaries are strictly off-limits to oil and gas exploration and exploitation. Finer *et al* (2008) concluded that the current overlay of oil and gas concessions across much of the Peruvian Amazon threatens biodiversity, indigenous peoples, and some of the largest remaining wilderness areas in the Amazon Basin.

One consequence of this situation has been escalating social conflict in the Peruvian Amazon region. In both 2008 and 2009, hostile confrontations have erupted between Amazonian indigenous peoples and the Peruvian government (Anaya 2009, Romero 2009). At the center of both conflicts were government efforts to lease or sell indigenous lands without the peoples' free, prior and informed consent (FPIC). Indigenous leaders often cite the environmental and health impacts associated with Amazonian hydrocarbon activities as one of the predominant factors behind their opposition. A pair of oil extraction projects begun in the 1970s has caused extensive contamination of the Corrientes River watershed in the northern Peruvian Amazon (Quarles 2009). Around 99% of the Achuar population that inhabits this area has unsafe blood levels of cadmium, a highly toxic and carcinogenic heavy metal associated with oil exploitation (Orta-Martínez *et al* 2007). Even the much newer Camisea natural gas pipeline in the southern Peruvian Amazon, which began operations in the fall of 2004 with higher operating standards, has already experienced six major spills and numerous leaks (Napolitano and Ryan 2007). Another issue of particular concern for indigenous peoples regards the growing number of hydrocarbon concessions overlapping proposed reserves for groups still living in voluntary isolation, whose lack of resistance or immunity make them extremely vulnerable to illnesses brought by outsiders (Defensoría del Pueblo 2006, Napolitano and Ryan 2007).

To date, there has been no comprehensive review of the history of hydrocarbon activities in the region or any projections of likely levels of activity in the near future and potential impacts to biodiversity, protected areas, and indigenous groups. This paper provides the first in-depth examination of the past, present, and future of hydrocarbon activities in the Peruvian Amazon. Our specific objectives are to: (1) present a quantitative review of hydrocarbon activities across the region over the past 40 years, (2) examine the status of all current concessions, particularly in terms of how they overlap protected areas and indigenous territories, (3) make quantitative projections regarding the wave of hydrocarbon activity set to hit the region over the next 5 years, and (4) discuss the potential environmental and social impacts that may accompany the projected levels of activity. We end with a brief set of recommendations on how the negative hydrocarbon-related environmental and social impacts may be avoided or minimized.

[4] Throughout this letter, the term 'indigenous' is meant to be synonymous with 'aboriginal'.

2. Methods

2.1. Secondary data collection

Our work is based on analysis of official government data collected by the Peruvian Ministry of Energy and Mines and the Peruvian state energy companies Petroperú and Perúpetro. Specifically, we extracted information dealing with contracts, seismic testing, well construction, oil development, and natural gas development for Amazonian oil and gas concessions for each of the past 39 years, allowing us to provide a complete picture of hydrocarbon activities in the Peruvian Amazon from 1970 to 2009. Information for activities prior to 1970 was pieced together as much as possible from these documents as well.

For the period 1970–89, all data come from annual Petroperú reports referred to as 'Informe Estadístico Anual' (Petroperú 1970–89) or 'Memoria Anual' (Petroperú 1970–95). Annual reports from the Peruvian Ministry of Energy and Mines (Ministerio de Energía y Minas 1970–71) along with summary reports from both Petroperú and MINEM for this period (Petroperú 1982, 1991, Ministerio de Energía y Minas de Perú 1986) have allowed cross-validation of data. Petroperú, founded in 1969 as part of the nationalization process of the oil industry, was the state agency that controlled oil exploration, exploitation, refining, transport, distribution and marketing in the domestic market. In 1991, some major components of Petroperú were privatized and as a result it stopped centralizing information as of 1990. In 1996, the Peruvian Ministry of Energy and Mines started serving as the centralized information source and are the source of data from 1990 to 2009. Data for this period was obtained from Ministry of Energy and Mines annual reports (Ministerio de Energía y Minas de Perú 1996, 1996–2009). Reports that cover the transition period between Petroperú and Ministry of Energy and Mines reporting has allowed us to cross-check seismic testing, well construction, and production data consistency among sources (Petroperú 1992, 1994a, 1994b, Ministerio de Energía y Minas de Perú 1996). For contract data, however, there is a reporting gap between 1990 and 1995. Contract data for this period comes from a number of different sources, including annual Petroperú reports (Memoria Annual), Petroperú statistics reports (Petroperú 1992, 1994a, 1994b), and annual reports referred to as 'Perú en números' (Webb and Fernández-Baca 1990–2009). We consider that contract data for the years 1990, 1991 and 1993 may be an underestimate. Cross-checking has not been possible for this data series. The historical data described here accounts for

much of the total activity as there were only two producing oil concessions in the Peruvian Amazon prior to 1970.

For the subsequent analysis, we selected several descriptive statistics to quantitatively summarize the detailed and novel database on historical oil and gas activities in the Peruvian Amazon presented here. We used frequencies of hectares under hydrocarbon concessions to describe the advance of the oil and gas frontier; frequencies of number of wells drilled and kilometers of seismic lines cut to describe the intensity of hydrocarbon activities undertaken; and frequencies on miles of barrel oil equivalents to give an overall sense of the requirement of further hydrocarbon exploration and exploitation to reverse depletion.

2.2. Projections

We generated a detailed database of every active and proposed concession in the Peruvian Amazon in order to produce the future projections. The projected area covered by concessions was calculated as the current concessions, plus the total area of all the proposed concession (areas in negotiation plus oil block 157, suspended since October 2008 due to a corruption scandal) plus Technical Evaluation Agreements (TEA or areas termed 'convenios' by Perúpetro). For the projected level of future seismic testing and exploratory well construction, we summed the (1) stated amount of planned activities in the environmental impact studies (EIS) of the concessions with a completed EIS, (2) likely minimal amount of activity for the concessions that do not yet have an available environmental impact study, and (3) likely minimal amount of activity for the proposed concessions. The likely minimal amount of activity was defined as 300 km 2D seismic testing and three exploratory wells since that is the stated work minimum in most hydrocarbon contracts for the Peruvian Amazon.

To better understand our results, it is helpful to review the typical minimum work program for new oil and gas concessions in the Peruvian Amazon. Perúpetro is the state company responsible for promoting the investment of hydrocarbon exploration and exploitation activities in the country. Perúpetro negotiates, signs and supervises all hydrocarbon contracts. When an oil or gas company signs a contract with Perúpetro, it commits to a minimal work program for that particular concession. The initial exploratory phase is for 7 years, during which time the company typically must complete at least 300 km of seismic testing and drill at least three exploratory wells. Many contract work programs exceed these minimums, particularly for the amount of seismic testing. Since 1993, an environmental impact study approved by the Peruvian government has been required before the start of any new exploratory or development activity (Glasson *et al* 2005). If oil or gas reserves are found during the exploratory phase, the company may then transition the concession into exploitation phase, which lasts another 23 years for oil production or 33 years for gas production (i.e. 30 or 40 year total contracts, respectively, although the concessions can be extended if necessary).

2.3. Spatial analysis

Spatial analyses were conducted using Geographical Information Systems to calculate overlaps among different land-use categories as proxies of the impact of hydrocarbon concessions on biodiversity and indigenous people. Biodiversity impacts were gauged via hydrocarbon concession overlaps of areas in the official protected area system, and impacts on indigenous people were gauged via hydrocarbon concession overlaps of titled indigenous lands and Territorial Reserves created for the protection of indigenous people in voluntary isolation. GIS data used in the spatial analysis include: oil and gas concessions from Perúpetro (2009); titled indigenous lands and proposed and approved territorial reserves for the protection of indigenous peoples in voluntary isolation from the Peruvian Ministry of Agriculture and the Instituto del Bien Común's System on Native Communities in the Peruvian Amazon (IBC 2009); Peruvian natural protected areas from the National Service of Natural Protected Areas (SERNANP 2009); and Peruvian Amazon according to ecological criteria, Institute for Investigation of the Peruvian Amazon (IIAP 1998). This information was used to create figure 4. The map of all current oil and gas concessions, proposed concessions, and technical evaluation agreement lots in the Peruvian Amazon was created by the Instituto del Bien Común in Lima, Peru. We only represented those elements that were completely or partially within the Peruvian Amazon.

To calculate the percentage of the Peruvian Amazon covered by hydrocarbon concessions, we used the size of the Peruvian Amazon as reported by the IIAP (1998) and modified in 2005 by the IIAP (Lizardo Fachín and Roger Escobedo, personal communication 2009)— 782 820.60 km^2. This figure includes the deforested area, so that it corresponds to the original Peruvian Amazon surface. Oil and gas concessions from 2002 to 2009 were available in geo-referenced files, and those from 1970 to 2001 have been geo-referenced and digitized from maps provided in annual Petroperú reports (Petroperú 1970–89, 1970–95) and annual Ministerio de Energía y Minas de Perú reports (Ministerio de Energía y Minas de Perú 1986, 1996, 1996–2009).

To calculate the area of the Peruvian Amazon directly impacted by seismic lines, we created a 2 km buffer around the seismic lines from the period 1970–2002 (previous to the second oil boom) and aggregated them into a unique polygon that resulted in an area of 207 623 km^2. There is only geo-referenced information for seismic lines cut before 2002, and for these years there is only information for 81 000 km of the 100 100 km seismic lines. Consequently, the total extension of the Peruvian Amazon impacted by seismic testing is an underestimate. The 2 km buffer criteria was selected as a compromise between small radius impacts (such as direct forest disturbance or deforestation) and long radius impacts (displacement of indigenous peoples in voluntary isolation).

3. Results

We found that more of the Peruvian Amazon has been leased to oil and gas companies over the past four years than at any other time on record (figure 1(a)). Records show 322 092 km^2,

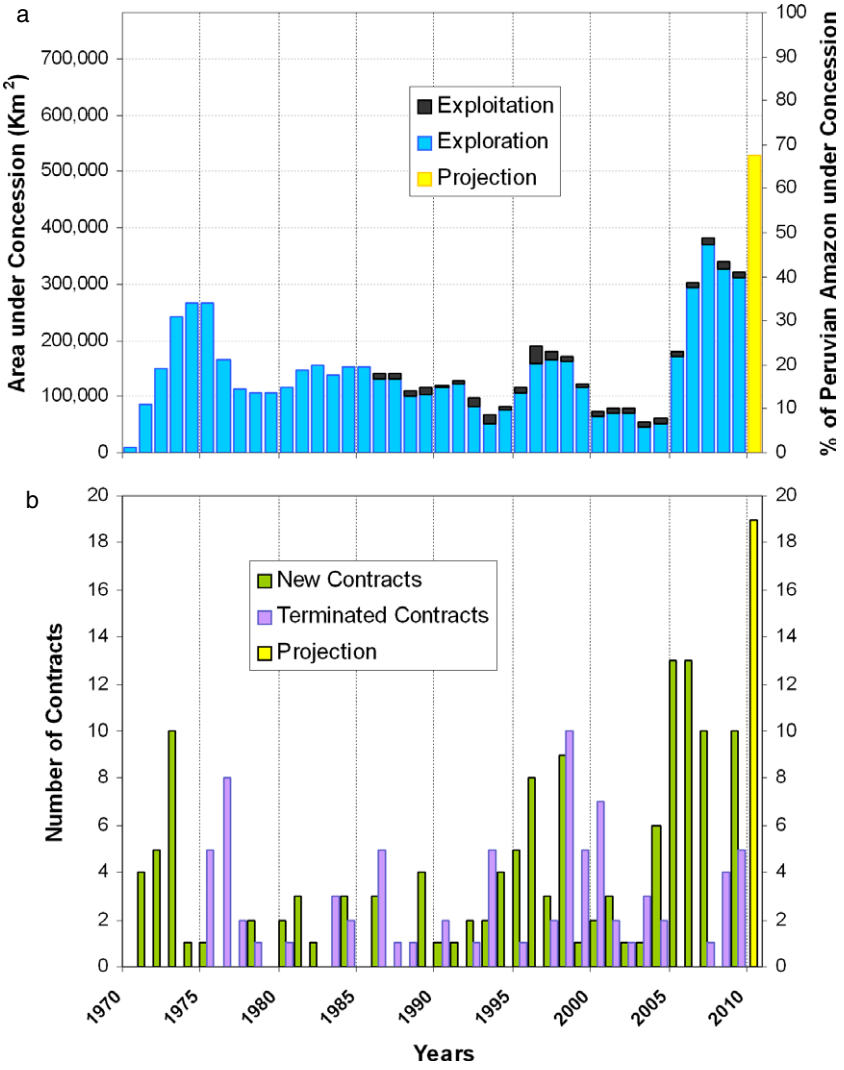

Figure 1. Oil and gas concessions in the Peruvian Amazon. (a) Area and per cent of the Peruvian Amazon under concession. (b) Number of new and terminated concessions.

or 41.2% of the Peruvian Amazon, under concession as of 31, December 2009. This is up from just 7.1% in 2003. The total area under concession peaked in 2007, with 48.6% of the Peruvian Amazon. Other lesser peaks of concessioned area occurred in the late 1990s and the early 1970s (figure 1(a)). A total of 69.1% of the Peruvian Amazon has been under oil or gas concession at some point between 1970 and 2009.

There were more active concessions in early 2009 then at any other time on record (figure 1(b)). As of 31, December 2009, there were 52 active Amazonian hydrocarbon concessions. Forty-two (81%) of these concessions are new, with the contracts signed between 2005 and 2009. Perúpetro set single year contract signing records in both 2005 and 2006, with 13 new Amazonian contracts each year. Across years, the vast majority of concessioned area has been in exploration phase (see figure 1(a)). For example, of the 52 current oil and gas concessions in the Peruvian Amazon, only seven are in exploitation phase while the remaining 45 are in exploration phase. Ten additional areas are currently under technical evaluation agreements bringing the total area under concession or technical contract up to 444 432 km^2, or 56.8% of the Peruvian Amazon. Eighteen additional Amazonian lots are now being offered as part of Perúpetro's 2010 bidding round, and one temporarily suspended concession is expected back in 2010 as well. All together, these 81 active and proposed oil and gas zones cover around 70% of the Peruvian Amazon. Among years where data is available (1999–2009), the peak area zoned for oil and gas activity (concessions plus technical evaluation agreements and proposed concessions) was 72% in 2008 (Finer *et al* 2008, Benavides 2009). Slightly over 84% of the Peruvian Amazon has been zoned for hydrocarbon activities at some point in time over the past 40 years.

Nearly 104 000 km of 2D seismic lines have been cut through the Peruvian Amazon over the past 40 years, plus over 3400 km^2 have been affected by 3D seismic testing. These seismic lines have directly impacted well over one-quarter of the Peruvian Amazon. There was an extraordinary period of seismic testing activity between 1972 and 1975, accounting for over half of all known seismic lines (figure 2(a)). 3D seismic testing—which forms tight grids, typically measured in square

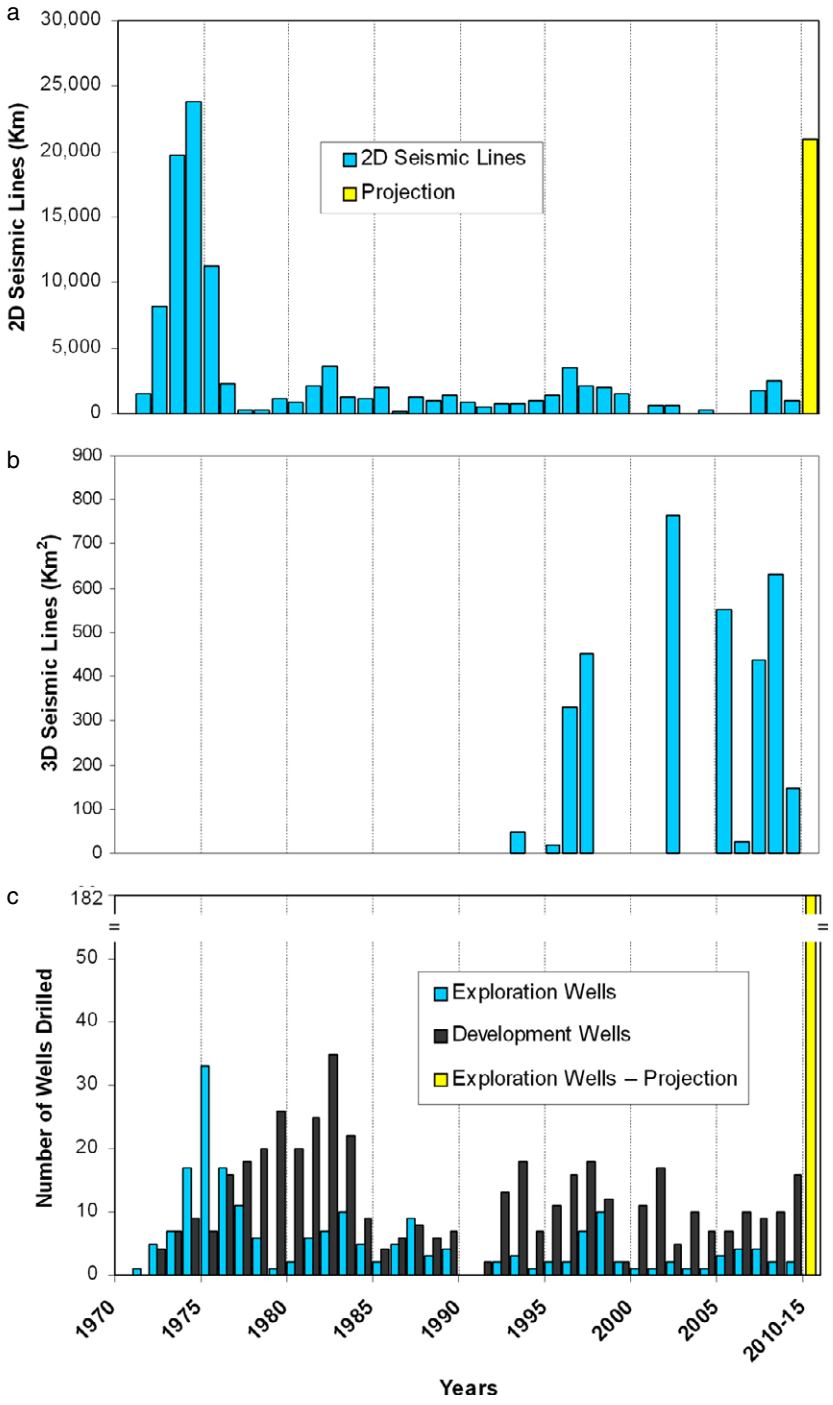

Figure 2. Oil and gas exploration and exploitation activities in the Peruvian Amazon. Level of (a) 2D seismic activity, and (b) 3D seismic activity. (c) Number of exploration and development wells drilled.

kilometers—has been utilized with greater frequency in recent years (figure 2(b)).

A total of 679 exploratory and production wells have been built in the Peruvian Amazon. The number of new exploratory wells peaked between 1974 and 1977 (figure 2(c)), directly following the peak in seismic testing. The peak of development well construction was between 1974 and 1984, with over 200 new wells (figure 2(c)). There are currently 266 oil-producing wells. All production wells have resulted in the extraction of around 996.3 million barrels of crude oil from the Peruvian Amazon since 1939. Oil production rose dramatically in 1978 with the start of major operations in concessions 1-AB and 8, and quickly peaked between 1979 and 1986. There has been a steady decline in oil production ever since peak production between 1979 and 1985 (figure 3(a)). In summary, oil exploration activities peaked during the early to mid-1970s, while production peaked early the following decade. In contrast, natural gas production has been steadily increasing since first tapped for commercial use in 1998 (figure 3(b)).

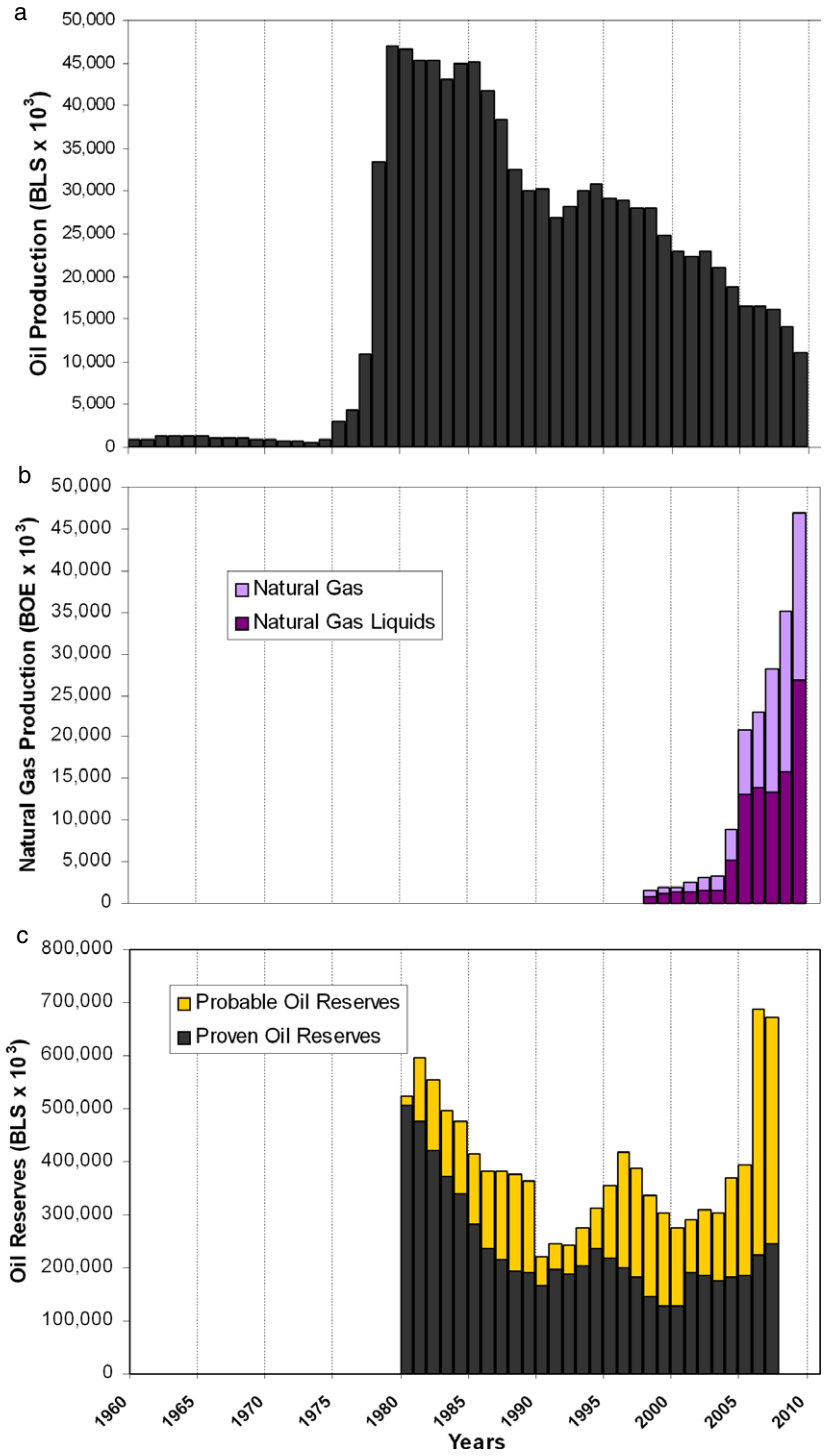

Figure 3. Oil and gas extraction and reserves in the Peruvian Amazon. Production of (a) oil and (b) natural gas. (c) Proven and probable oil reserves. BOE, Barrel Oil Equivalent; BLS, barrels.

A major spike in natural gas production occurred in 2004 due to the start of production at Camisea.

Based on an analysis of the typical minimum work program for new concessions, we generated projections for the amount of exploratory activity expected in the near future. We forecast that there will be a continued rise of both seismic testing and exploratory well construction over the next several years, likely reaching levels not seen since the mid-1970s (see figure 2 parts (a) and (c), respectively). We project that ∼21 000 km of seismic lines will be cut through the Peruvian Amazon over the next 5 years. In addition, we project that ∼182 exploratory wells may be drilled during this time period as well.

Oil reserves (proven and probable) of the Peruvian Amazon jumped in 2006, to nearly 674 million barrels (figure 3(c)). This jump was due to the addition of probable reserves first discovered in the late 1990s in a concession

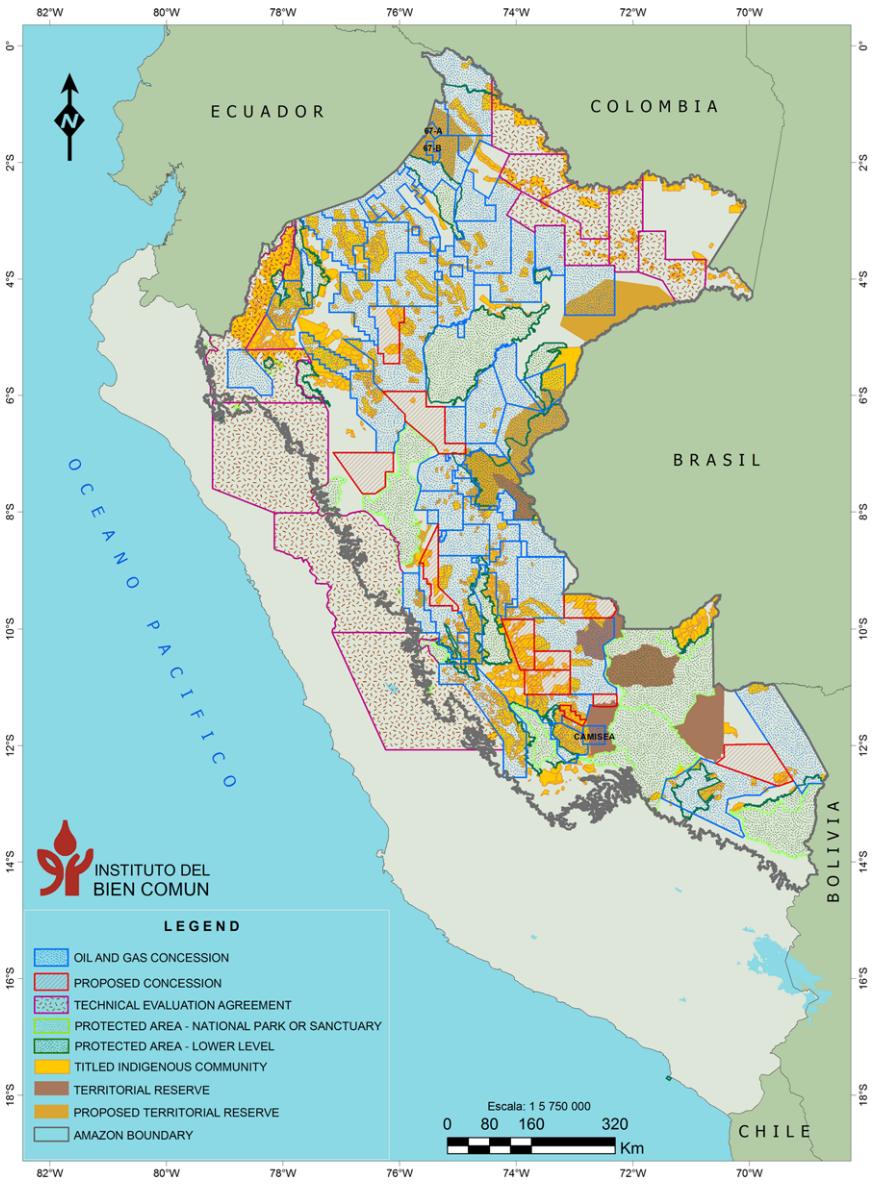

Figure 4. Map of all current oil and gas concessions, proposed concessions, and technical evaluation agreement lots in the Peruvian Amazon. These hydrocarbon zones overlap both protected areas and indigenous peoples' territories.

known as Block 67. Natural gas reserves (proven and probable) are substantial, with around 15.4 trillion cubic feet, plus an additional 928.4 million barrels of liquid natural gas.

The vast majority of the concessions overlap sensitive areas (figure 4). Of the 52 active concessions, 46 (88%) overlap titled indigenous lands and 17 overlap proposed or created territorial reserves for indigenous people living in voluntary isolation. The result is that 55.1% of the 100 367 km^2 titled indigenous lands[5], 17.1% of the 29 282 km^2 created territorial reserves (down from 41.9% earlier in the year), and 60.9% of the 42 151 km^2 proposed territorial reserves are covered by hydrocarbon concessions. Twenty-one concessions overlap nature reserves within the Peruvian protected area system and an additional eight concessions overlap the Abanico del río Pastaza, a large wetland complex considered by the Ramsar Convention as a wetland of international importance. Thus, 17.1% of the 153 539 km^2 Peruvian Amazon protected area system, plus 81.5% of the 24 049 km^2 Abanico wetlands, are covered by hydrocarbon concessions. In addition, at least eight of the new 2010 bidding round proposed concessions overlap titled indigenous lands, and one overlaps part of a territorial reserve.

4. Discussion

We found that the Peruvian Amazon is now in the early stages of a second hydrocarbon exploration boom. The first exploration boom occurred in the early to mid-1970s and was characterized by an extraordinary burst of seismic activity.

[5] Our results differ a little bit from those of Benavides (2009), who states that the titled indigenous land covers 102 634 km^2 of the Peruvian Amazon. In calculating this percentage we have not taken into account the 277 indigenous communities awaiting titles. 53.5% of their territory are also covered by oil and gas concessions.

Nearly 63 000 km of seismic lines were cut during the four years between 1972 and 1975, over half of all historic activity. We project that the second boom will consist of around 21 000 km of seismic lines over the next 5 years. This should be considered a conservative estimate, however, given that many modern seismic campaigns greatly exceed what is called for in the minimum work program that formed the basis of our projections. Our projections also show that the number of exploratory wells to be drilled in the Peruvian Amazon over the next several years—around 182— may exceed that of the mid-1970s peak.

The number of new exploration contracts spiked between 2005 and 2009, resulting in more active concessions and more Amazonian land area covered by concessions than at any other time in Peru's history. The jump in the percentage of the Peruvian Amazon covered in hydrocarbon concessions between 2005 and 2007—7%–49%—exceeds that of the concession expansion leading to the first exploration boom of the 1970s. During the peak of the 1970s exploration boom, only 34% of the Peruvian Amazon was under concession. When proposed concessions are included in the analysis, we found that nearly two-thirds of the Peruvian Amazon is now zoned to hydrocarbon activities. This number could continue to rise as only 10% of the Peruvian Amazon is currently off-limits to oil concessions. Indeed, 18 new proposed concessions were unveiled in early 2010.

The region may be on the verge of a second exploitation boom as well. Although oil production in the Peruvian Amazon has been steadily falling since its peak in 1979—2009 marked the lowest output in over 20 years (see figure 3(a))—it may soon increase sharply if production starts in the extremely controversial Block 67 (see below). Natural gas production still has not peaked, and annual gas production is expected to keep rising due to the large Camisea reserves. Indeed, 2009 marked the sixth consecutive year of rapidly increasing annual gas production (see figure 3(b)). With this skyrocketing natural gas production, total hydrocarbon production (combining both oil and gas) actually reached its historical maximum in 2009.

Increasing global oil demand and consumption, combined with the high oil prices from 2003–2008, spurred energy company commitments to relatively high-cost exploration and exploitation projects (US Energy Information Administration 2009). Indeed, one of the more troubling aspects of the new exploration boom is that areas previously protected by their remoteness are now covered by proposed or active oil concessions. Many areas untouched by the seismic testing wave of the 1970s are now in active or proposed concessions. In other words, there has been a rapid expansion of the oil frontier in the Peruvian Amazon. This expansion includes the unprecedented coverage of protected areas and indigenous territories, particularly areas utilized by vulnerable indigenous peoples in voluntary isolation. Nearly one-fifth of the Peruvian Amazon protected area system is covered by hydrocarbon concessions, while that figure rises to over 60% for proposed territorial reserve area for uncontacted indigenous peoples.

Our finding that over 84% of the Peruvian Amazon has been or is currently zoned for hydrocarbon activities raises many questions. For example, what has been the cumulative impact of well over 100 000 km of seismic lines cut through primary Amazonian forest? Little is known about the environmental impacts from exploratory seismic testing, particularly the much more work-intensive 3D form that is now being used with greater frequency. During the exploration phase, there is deforestation related to the construction of the base camp, sub-bases, and the numerous heliports. Most modern seismic projects require at least 50 heliports, and larger seismic projects may call for hundreds of heliports. There are also potential environmental impacts from helicopter noise, the influx of a large amount of seismic crew workers into remote areas, the cutting of hundreds of kilometers of seismic lines through the understory—which may act as new hunting or logging trails deep into remote forest—and the detonation of thousands of seismic explosives (Thomsen *et al* 2001). A recent study on the impacts of 2D seismic testing in a remote, intact section of the Peruvian Amazon (Block 39) found a significant decrease in the group sizes of the Endangered White-bellied Spider Monkey (*Ateles belzebuth*) during the seismic testing phase (Smithsonian Conservation Biology Institute 2009). Although no negative impacts were detected in the study's focal species, the Ocelot (*Leopardus pardalis*), it is clear more research is needed on the impacts of seismic testing in mega-diverse environments.

During the production phase, the environmental impacts are potentially much more severe and extensive. Therefore, what has been the cumulative impact from the drilling of nearly 700 wells and the exploitation of nearly a billion barrels of oil from the Peruvian Amazon? The contamination of the Corrientes region is now well-documented (Orta-Martínez *et al* 2007, Quarles 2009). And although direct contamination and pollution per unit of production will presumably never again be as bad as the 1970s era projects due to much improved regulations and standards, modern production sites and pipelines are still prone to accidents, leaks, and spills (Napolitano and Ryan 2007). And since pipelines often extend over hundreds of kilometers, impacts are not isolated exclusively to the extraction site. The indirect impacts associated with new hydrocarbon-related access routes are also especially severe. Roads and pipeline routes connecting to the drilling platforms can open up previously remote areas, triggering an array of indirect impacts such as colonization, illegal logging, and unsustainable hunting (Rosenfeld *et al* 2001, Greenberg *et al* 2005, Suárez *et al* 2009). Indeed, the expanding oil frontier has the unique potential of advancing the agricultural, cattle and logging frontiers as well (Viña *et al* 2004, but see Wunder 2003).

As demonstrated by the deadly confrontations between indigenous protesters and police in June 2009, there are major hydrocarbon-related social impacts as well. Our finding that over half of all legally titled indigenous territories in the Peruvian Amazon are covered by hydrocarbon concessions may help explain the intense frustration of the indigenous peoples of the region, many of whom have struggled for decades to get legal title for at least a portion of their ancestral territories. According to monthly reports from the Peruvian ombudsman, hydrocarbon-related socio-environmental conflicts are increasing in the

Peruvian Amazon. Furthermore, our finding that 42% of the territorial reserves, and over 60% of the proposed territorial reserves, were covered by hydrocarbon concessions in 2009 point to the grave threat posed to uncontacted indigenous peoples. Concession creation and subsequent project development without the previous consent of local peoples and potential health-related impacts (Orta-Martínez *et al* 2007, San Sebastián *et al* 2001, Hurtig and San Sebastián 2002)—particularly for indigenous peoples living in voluntary isolation, whose lack of resistance or immunity make them extremely vulnerable to illnesses brought by outsiders (Defensoría del Pueblo 2006, Napolitano and Ryan 2007)—are two of the most volatile hydrocarbon-related social issues. Subsequent acculturation of indigenous peoples and their integration into the market economy (Godoy *et al* 2005) can lead to another major threat to biodiversity conservation since biological and cultural diversity are often mutually dependent and geographically conterminous (Toledo 2001).

The proposed oil exploitation project in Block 67 is a prime example of the potential environmental and social impacts associated with a modern hydrocarbon boom in the Peruvian Amazon. Located in a remote region near the border with Ecuador, this concession is slated to be the first major new oil production project in the Peruvian Amazon in over 35 years and would likely bring total oil production in the Peruvian Amazon near the production records set in the late-1970s and early-1980s. Development in Block 67, however, is extremely controversial. This concession lies within a mega-diverse and largely intact section of the Amazon, sparking intense environmental concerns. Moreover, there is strong anthropological evidence that uncontacted indigenous peoples have traditionally utilized the area (Rogalski and Wolodzko 2005). Indigenous groups have launched both domestic lawsuits and a petition to the Inter-American Commission on Human Rights (an organ of the Organization of American States) with the aim of blocking development of Block 67.

5. Conclusion

We argue that a rigorous policy debate, including a greater analysis of potential environmental and social impacts, is urgently needed as the Peruvian Amazon is set to face a dramatic increase in hydrocarbon-related activity. The first Amazonian oil exploration and exploitation boom occurred in the 1970s and resulted in major environmental and social impacts. Therefore, one of the critical questions arising from our findings is what type of environmental and social impacts are likely during a modern hydrocarbon boom, and what can be done to eliminate or minimize these impacts. For example, Peru's neighbor Ecuador is currently pursuing an innovative new initiative to permanently leave known oil reserves locked under the ground in order to avoid the environmental and social impacts of Amazonian oil development (Larrea 2009, Finer *et al* 2010). Ecuador seeks alternative sources of revenue from the international community to offset the financial loss of not extracting the oil in three fields, known collectively as ITT. Given that the controversial Block 67 is just across the border from ITT, perhaps Peru could employ a similar strategy to avoid impacts in this bi-national region of extraordinary biodiversity and uncontacted indigenous peoples. As global demand for oil increases while conventional oil reserves decrease, some of the world's most remote and ecologically intact regions, such as the Peruvian Amazon, are increasingly vulnerable to industrial activity without markedly improved policy measures.

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