Emerging Infectious Diseases and Impact Assessments

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Industrial development and operations in developing countries often involve deforestation, habitat fragmentation, human population movement, road building, water and air pollution, and hydrological changes. Activities associated with industrial development can have cascading effects that exacerbate disease emergence (Patz et al. 2004). However, limited research exists that documents specific effects of industrial practices on infectious disease emergence. Many industries actively mitigate the potential adverse effects of their operations on wildlife and promote biodiversity, but they do not consider the potential transmission of zoonotic pathogens. This paper discusses how impact assessments can use the tools described to help industry understand and mitigate vulnerabilities to zoonotic disease transmission.

The paper provides background information on emerging infectious diseases of zoonotic origin; reviews linkages between land use change, activities associated with industrial development, and the potential for emergence and/or transmission of zoonotic diseases; and finally presents tools for companies considering or operating in emerging infectious disease "hot spot" areas of the world to evaluate their vulnerabilities to potential zoonotic disease transmission within the impact assessment process.

Nearly three-quarters of emerging infectious diseases originate from wildlife (Jones et al. 2008; Woolhouse and Gowtage-Sequeria 2005) and is predicted to occur in Latin America, Africa and Asia (Jones et al. 2008). Three animal orders are known for most commonly spreading new infectious agents to people: bats (e.g. SARS-corona virus, Nipah virus), rodents (e.g., Lassavirus, hantavirus, monkeypox and Lyme disease bacteria) and non-human primates (e.g., Ebola, Simian immunodeficiency viruses (SIV)). The transmission routes from these animals to people include scratches, bites and contact with bodily fluids (i.e., blood and saliva) through activities such as butchering animals, by breathing contaminated aerosolized feces or urine, consuming contaminated food or water, and being bitten by insect vectors (Belmain et al. 2002; Chapman et al. 2005; LeBreton et. al. 2006; Mills 2006; Wong et. al. 2007).

In general, land use and landscape changes can contribute to habitat loss or fragmentation; this can increase contact between human and wildlife host populations, thus creating increased opportunities for cross-species transmission (Keesing et al. 2010). In general, opportunistic species, particularly rodents, can thrive in disturbed habitats (Mills 2006). A current theory surmises that if pathogen host species are generalists and the newly formed habitat is suitable, the potential for pathogen transmission to people increases (Dearing and Dizney 2010).

When industries enter previously undeveloped or lightly developed areas, they often import a large labor force. Local food production needs increase to feed the growing community, and this creates pressure for agricultural and livestock expansion. Many types of agricultural crops are foods for rodents, bats and non-human primates (Mills 2006; Mickleburgh et. al. 1992; Hockings and Humle 2009). Domestic animals also can serve as intermediate hosts for pathogens carried by wild animals (Wilcox and Ellis 2006). Road development can provide access to previously inaccessible areas, making wildlife hunting easier (Laurance et al. 2009).

Human population migration and resettlement associated with developing new transportation routes involve road building and forest clearing and can be local or regional drivers of disease emergence (Wilcox and Ellis 2006). Because industrial workers live in or interact with surrounding communities, health issues that arise in local communities are a concern to industry. Other people often follow to seek jobs or establish businesses to serve the area's new worker population. This project-induced migration can raise disease transmission rates if not adequately planned. Strains on existing housing and infrastructure can lead to overcrowding, poor sanitary conditions, improper waste storage, and insufficient potable water (IFC 2009a).

These above-described conditions create opportunities and increased risk of novel pathogen transmission to humans and amplify the potential for disease transmission among human populations, as illustrated in Figure 1 that shows the link between extractive industries and land use change leading to infectious diseases. The graphic shows onshore oil/gas but is equally applicable to other industries such as mining and timber.

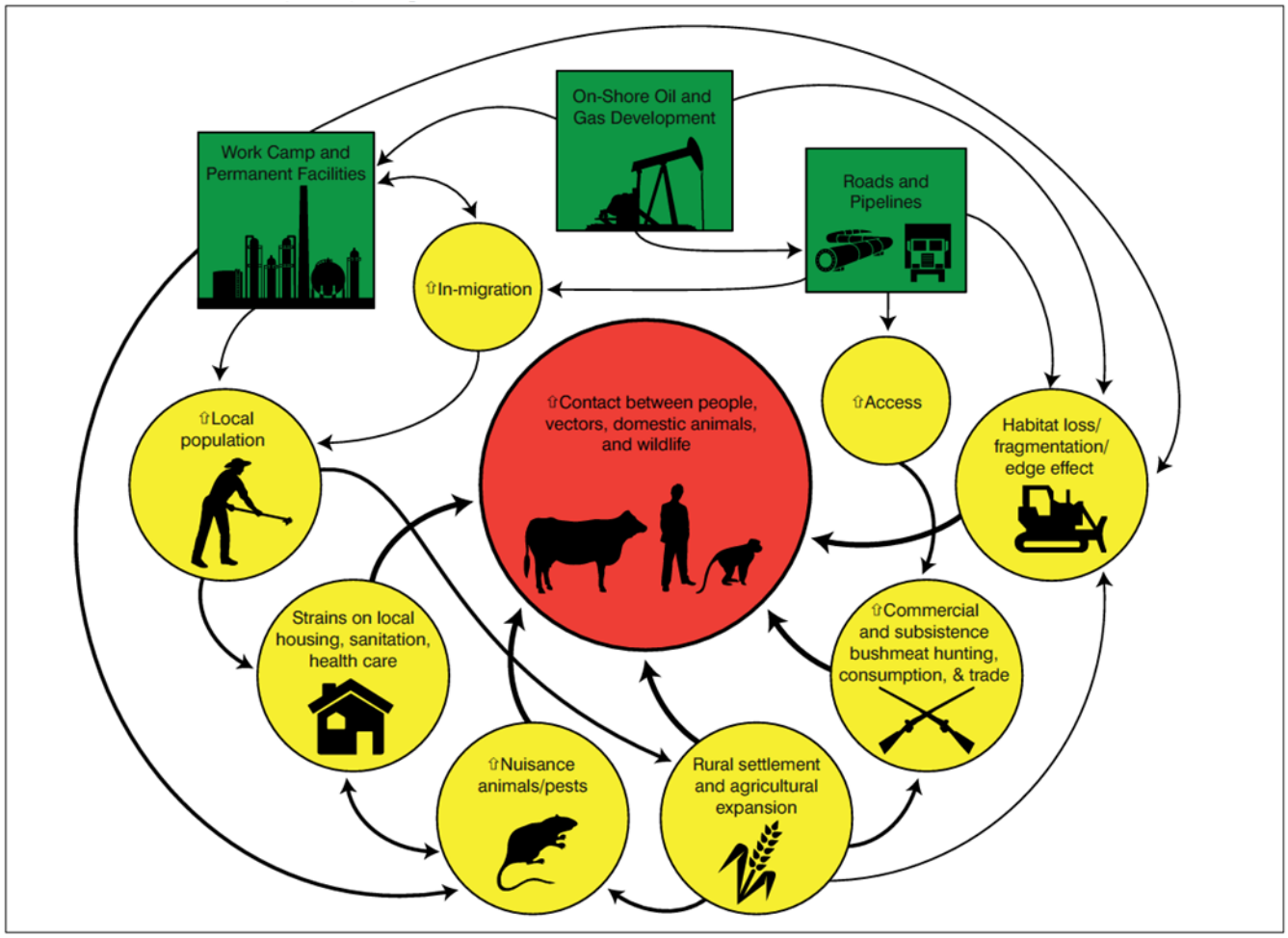

Figure 1: Cascading effects of on-shore oil development on increasing contact among people, domestic animals, vectors and wildlife.

The United States Agency for International Development (USAID) and its partner projects have developed tools to help governments and extractive industries evaluate potential vulnerabilities to pathogen transmission and identify potential mitigation measures. Currently USAID is testing the tools for the planning and operational stages of a project. The Planning Tool provides the steps to incorporate emerging infectious diseases of zoonotic origin into an Environmental, Social, and Health Impact Assessment (ESHIA) process. This tool could also be used at the feasibility study/preconstruction stage of a project. The Planning Tool includes the following list of screening questions (see Table 1) to help determine whether a project should consider zoonotic disease transmission risks.

Table 1: Planning Tool Screening Questions

Screening Questions	Yes/No	Notes
1. Will the project be located in an area where there are wildlife species that host zoonotic diseases?		Hot spots with a high concentration of emerging infectious diseases are located throughout the world.

Table 1: Planning Tool Screening Questions		
Screening Questions	**Yes/No**	**Notes**
2. Will the project be located in a previously undeveloped area? (Will existing land use change significantly from undeveloped to developed?)		The likelihood of contact with wildlife, their fluid, or excreta increases in areas being converted from natural habitats to developed areas.
3. Will the project require constructing roads or corridors?		Roads and corridors increase the interaction of human and wildlife by opening up new areas for hunting. Roads are used to transport bush meat.
4. Will an on-site temporary or permanent camp be established?		Camps, canteens, and waste management facilities can attract wildlife, increasing potential contact between people and wildlife and their excreta and increasing transmission risk.
5. Will a new transportation network be developed to move the resource (e.g., timber, ore, oil) and/or staff to and from the facility? (roads, rail, airstrips, helipads)		Exposed people could leave the facility without knowing that they are sick and expose others along transportation routes.
6. Will a relatively large labor influx occur compared to the existing population? Will populations be displaced or resettled?		New immigrants to an area may not have immunity to endemic diseases or may bring new diseases to an area. Project-induced labor and other in-migration can strain the local health and other infrastructure system. Poorly functioning water and waste management and health care systems can result in the amplification of infectious disease transmission.
7. Will livestock be on-site or near the site? Will staff be allowed to have pets on-site?		Pathogens can be transmitted between wildlife and domestic animals. People can then acquire pathogens from domestic animals.
8. Will there be on-site agricultural production? Will additional in-migration lead to agriculture expansion in adjacent areas?		Grain and fruit production attracts wildlife. Food products can be contaminated from animal byproducts (i.e., urine and feces) and/or direct contact with wildlife.
9. Will the infrastructure in surrounding communities be insufficient to accommodate any anticipated population expansion? Is this already a problem?		Insufficient potable water, sanitation, health care, and vector control can amplify any infectious disease that occurs locally.

Adapted from IFC 2009b.

To help answering question 1, USAID's PREDICT project developed the Disease Identification Toolkit, a searchable online database that can provide location-specific baseline zoonotic disease information along with wildlife species known as disease hosts and reservoirs. If the Toolkit identifies zoonotic diseases or wildlife hosts for zoonotic diseases are present and the project will engage in multiple activities identified above, then the project proponent should consider assessing the potential impacts of zoonotic diseases in the environmental and social impact assessments/environmental, social, and health impact assessments/health impact assessments (ESIA/ESHIA/HIA). To assess the risks and potential impacts of emerging infectious diseases, identifying wildlife species endemic to a project area is critical. By linking these species to their associated known zoonotic pathogens a crude assessment of the potential zoonotic disease risk from wildlife can be obtained, and combined findings with similar assessments of disease risks to human and domestic animal health. Then by analyzing the types of activities planned, it is possible to identify those activities that increase potential exposure and/or wildlife-human interaction. The data collection areas that are not normally part of an ESIA/ESHIA/HIA but should be examined include:

1. Obtaining or generating a species list of wildlife endemic to the area and determining whether these species are potential carriers of zoonotic diseases, what their behaviors are and what they eat
2. Determining whether wild animal meat or bushmeat is used as a source of protein and what species are hunted

3. Determining the methods used to harvest, butcher, transport, and prepare wild animals for human consumption
4. Determining how local human populations interact with rodents, bats, and non-human primates, and what potential exposure pathways exist between these animals and humans in the area
5. Determining the capacity of the local human community's infrastructure with respect to potable water supply, sanitation, vector control, and health care

Examples of project data to consider and evaluate would include:

1. If temporary or permanent living quarters will be present at the facility
    a. Quality of on-site housing with respect to ventilation, space, and sanitation
    b. Measures to protect facilities against non-human primates, rodents, and bats
2. If a canteen will serve workers at the facility
    a. Food handling procedures
    b. Quality and type of food storage
    c. Food disposal methods
3. If an on-site health care facility will be operational
    a. Capacity
    b. Disease outbreak preparedness plan
4. Waste management
    a. Pest control measures
5. Biodiversity monitoring and management strategy
6. Bushmeat policy
7. Agricultural development on-site

Discussions with stakeholders that would supplement the evaluation of potential transmission routes and zoonotic disease risks could include:

- Disease outbreaks among humans, domestic livestock, wildlife
- Wild animals for human consumption – species hunted, butchering and cooking techniques
- Contact with rodents, bats, and non-human primates
- Nuisance wildlife or pests and methods of deterrence and control
- Infrastructure capacity – potable water, sanitation, health care, and vector control

Many issues or vulnerabilities associated with zoonotic disease transmission that an assessment could identify will likely be addressed by mitigation measures that may already be included in an Environmental and Social Management Plan or Health Action Plan. Most mitigation measures address other public health, environmental, or social issues. Table 2 lists some potential mitigation measures to address vulnerabilities associated with zoonotic disease transmission.

Table 2: Illustrative Mitigation Measures

Mitigation Measure	**Timing**	**Indicators**	**Surveillance Method**
Institute a no-bushmeat-hunting policy within the concession	Construction to Decommissioning	• Presence/absence of on-site poaching, • Number of confiscations	Company security
Educate project workers and locals about zoonotic disease risks, how to avoid encounters with wildlife, and what to do if bitten, scratched, etc.		• Number of workers/locals trained • Number of adverse encounters	Incidence recorded at company clinic
Train locals about issues associated with bushmeat hunting and proper methods to butcher		• Number of people trained	N/A
Risk: Indirect contact with infected animals (can occur through consuming food/liquids contaminated with animal excreta or from insect vectors)			

Table 2: Illustrative Mitigation Measures			
Mitigation Measure	**Timing**	**Indicators**	**Surveillance Method**
Review food safety and security procedures	Design to Operations	• Food safety procedure implemented	Food safety audit
Review food storage methods and protections		• Presence/absences of pest prevention measures	Food safety audit
Review waste disposal and management		• Daily cover • Pest control	Environmental Management Review/Audit
Review housing design to ensure adequate measures exist not to promote or facilitate infectious disease transmission	Design to Decommissioning	• Occupants per room • Food storage • Sanitation	Housing audit
Conduct health education programs for project workers regarding infectious diseases transmission	Construction to Decommissioning	• Number of workers trained	Worker testing; audit practices, incidence of infectious diseases
Risk: Changes to surrounding communities due to the presence of a facility could increase contact with wildlife (direct contact) and/or result in increased transmission of infectious diseases that occur locally (amplification)			
Assist the local community to plan infrastructure and utilities (waste disposal, potable water, health care facilities)	Design to Decommissioning	Number of plans developed and implemented	Review plans annually
Educate community representatives about vector breeding site control and maintaining drainage during rainy seasons.		Number of meetings/workshops	Site audit
Support the training of local community health personnel in infectious disease surveillance and outbreak response		Number of people trained Presence/absence of plan	Presence of a functioning disease surveillance program

Adapted from IFC 2009b.

Extractive industries can proactively decrease the risks of disease outbreaks and zoonotic disease emergence and maintain worker productivity. By using the measures recommended, risks to worker health in general would be diminished, thus lessening the potential for infectious disease outbreaks, and thereby reducing the risk of emerging infectious disease. The tools developed by USAID and its partners are relevant for use as part of an ESIA or HIA to help new projects identify activities that increase the potential for zoonotic disease transmission and adopt measures to mitigate those routes of potential exposure and ultimately prevent future pandemics.

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