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Illicit Trade and Biological Risk

The health of people, animals, plants, and the environment exist in a linked system. The actions of illicit activity and trade, when combined with biological activity, can create biorisks. Biorisk is the "likelihood and consequences that a particular biological event (naturally occurring diseases, accidents, unexpected discovery, or deliberate misuse of biological agents and toxins) may affect adversely the health of populations".[1] There are various consequences of illicit trade where biological material is the source of harm. A globalized world offers opportunity for proliferation of illicit actions that can result in the spread of pathogens, and poor health outcomes for people, animals, plants, and their shared environment – regardless of the intended consequences. This perspective on health is defined as One Health (optimal health of humans, animals, plants, and their shared environment).

The negative externalities of illicit activity are commonly linked to violence, financial flows, or organized criminal activity but less frequently focused on biological catastrophes, such as pandemics and bioweapons. Understanding the illicit trade correlations, or causal links, of biological threats can help to determine how they might be mitigated and combated. It is important to prevent the introduction of emerging disease infections, alien species, secure agents in laboratories; and to prevent health impacts. Some regulations limit the movement and trade of high consequence biological materials and infectious materials.[2, 3] Emerging disease is the novel occurrence of a disease, infection or infestation, that causes significant impact on animal or human public health resulting from: (1) a change of a known pathogenic agent or its spread to a new geographic area or species; or (2) a previously unrecognized pathogenic agent or disease diagnosed for the first time.[4]

It is known that some disease emergence is related to deforestation, agricultural intensification, antimicrobial resistance, illegal wildlife and animal trade, and bushmeat

[1] "WHO_HSE_GAR_BDP_2010.2_eng.Pdf," accessed November 29, 2021, https://apps.who.int/iris/bitstream/handle/10665/70507/WHO_HSE_GAR_BDP_2010.2_eng.pdf;jsessionid=B58DAE2712F93DB1CD673B58C9725F00?sequence=1.
[2] Lela Bakanidze, Paata Imnadze, and Dana Perkins, "Biosafety and Biosecurity as Essential Pillars of International Health Security and Cross-Cutting Elements of Biological Nonproliferation," BMC Public Health 10, no. 1 (December 3, 2010): S12, https://doi.org/10.1186/1471-2458-10-S1-S12.
[3] Tatyana Novossiolova et al., "Strengthening the Biological and Toxin Weapons Convention: The Vital Importance of a Web of Prevention for Effective Biosafety and Biosecurity in the 21st Century," n.d., 24.
[4] "Oie-Terrestrial-Code-1_2019_en.Pdf," accessed December 13, 2021, https://rr-europe.oie.int/wp-content/uploads/2020/08/oie-terrestrial-code-1_2019_en.pdf.

consumption.[5] Some scholars have listed pandemic drivers (i.e. climate change, biodiversity loss, land degradation) as resulting from "consumption, and destruction of the natural world, caused by capitalism, and globalization."[6] These activities might have a link to illicit trade. The topic of illicit trade may be better known for narcotics, human smuggling and trafficking or firearms. But also linked to illicit activity are environmental crime, counterfeit medicines, sale of antimicrobials, dual use science (including synthetic or novel pathogens), bio-cybersecurity, food safety, livestock animal trade, and pesticides.[7] These biological-related risks are very apparent as the world is still combatting a global pandemic. Biorisks generated by illicit trade may rise to the importance of other national and international security issues. Many of these risks could impact the United States National Critical Functions; such that the 'disruption, corruption, or dysfunction would have a debilitating effect on security, national economic security, national public health or safety'.[8] We seem to be on a path to deplete the resources on planet Earth – and illicit trade is driving some of this.[9]

This paper will explore two areas of One Health biorisks and their link to illicit activity: illicit animal trade for consumption (i.e. wet markets/bushmeat and livestock), and dual use science (i.e. nefarious biology and bioterrorism). Biorisk from illicit trade involves more than the spill-over of pathogens between wildlife, domestic animals, and humans. The intersection of illicit trade and biorisk will be explored to consider biological One Health threats to humans, animals, plants and their shared environment. The conclusion will suggest that laws and regulations should focus on consumed species, natural resource sustainment, and control of scientific innovation. Healthy ecosystems are of public health interest.[10]

Biosecurity breaches due to illicit trade

Biosecure trade is an age-old problem but global catastrophic risks due to illicit trade are, perhaps, our newest problem.[11] There are many threats such as infectious disease, accidental

[5] "A-Wildlifehealth-Conceptnote.Pdf," accessed September 27, 2021, https://www.oie.int/app/uploads/2021/03/a-wildlifehealth-conceptnote.pdf.
[6] Colin J. Carlson, Gregory F. Albery, and Alexandra Phelan, "Preparing International Cooperation on Pandemic Prevention for the Anthropocene," BMJ Global Health 6, no. 3 (March 1, 2021): e004254, https://doi.org/10.1136/bmjgh-2020-004254.
[7] Louise I. Shelley, Dark Commerce: How a New Illicit Economy Is Threatening Our Future ((Princeton University Press), n.d.).
[8] "National-Critical-Functions-Overview-508.Pdf," accessed December 12, 2021, https://www.cisa.gov/sites/default/files/publications/national-critical-functions-overview-508.pdf.
[9] Shelley, Dark Commerce: How a New Illicit Economy Is Threatening Our Future (.
[10] Joel Henrique Ellwanger et al., "Control and Prevention of Infectious Diseases from a One Health Perspective," Genetics and Molecular Biology 44, no. 1 (2021), https://doi.org/10.1590/1678-4685-gmb-2020-0256.
[11] "Biosecurity Basics - YouTube," accessed November 30, 2021, https://www.youtube.com/watch?v=Q9ZhkceMW70&t=87s.

research incidents, or the use of disease as a weapon.[12] Some laws regulate the transportation of pathogens in formal global commerce. Globally, international veterinary certificates prove the health status of traded animals. These trade laws attempt to prevent viruses, bacteria, protozoa, fungi, prions, and novel pathogens from gaining access to new hosts. Some of these policies are the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and World Trade Organization Sanitary and Phytosanitary Measures.[13] In spite of these regulatory agreements, spillover events of emerging infectious diseases are increasing."[14] One recent issue is the disease of SARS-CoV-2; humans and animals were infected by it, and trade and transit were affected as well. Brief examples of SARS-CoV-2 related illicit activity is the incidents of counterfeit SARS-CoV-2 vaccination record cards and counterfeit personal protective equipment (both of which can harm people).[15]

Outcomes of biosecurity breaches due to illicit activity can affect the health of humans, animals, and the environment. Human health can be harmed by examples of disease such as Ebola, or food borne illness. The health of animals can be harmed by spillback of infectious disease from humans, or through the transfer of transboundary foreign animal disease. Diseases can be introduced to other animals. Two examples are Foot and Mouth Disease (FMD), and African Swine Fever (ASF). Further, many species can suffer together from antibiotic resistance, spread of transgenes from genetically modified crops, loss of biological diversity, natural resource depletion, or deliberate biological incidents (i.e. bioterrorism). One way to undermine appropriate trade in animals is to falsify health certificates (like falsified human vaccination cards).

These poor outcomes can be caused by illicit actors. Many illicit channels involve those who will not comply with laws, trade restrictions or health regulations.[16] There are supply chain transparency problems that can allow illicit supply chains to enter the legitimate economy.[17]

[12] Gregory D. Koblentz, "Biosecurity Reconsidered: Calibrating Biological Threats and Responses," International Security 34, no. 4 (April 2010): 96–132, https://doi.org/10.1162/isec.2010.34.4.96.
[13] "WTO | Sanitary and Phytosanitary Measures - Text of the Agreement," accessed December 13, 2021, https://www.wto.org/english/tratop_e/sps_e/spsagr_e.htm.
[14] "One Health: Preventing and Solving Public Health Disasters | Findings | University of Michigan School of Public Health | Infectious Disease | Environmental Health," accessed December 6, 2021, https://sph.umich.edu/findings/fall-2021/one-health-preventing-and-solving-public-health-disasters.html.
[15] "CBP Seizes Counterfeit N95 Masks | U.S. Customs and Border Protection," accessed December 13, 2021, https://www.cbp.gov/newsroom/local-media-release/cbp-seizes-counterfeit-n95-masks.
[16] "Illicit Trade: Converging Criminal Networks," Text, accessed September 13, 2021, https://www.oecd-ilibrary.org/governance/charting-illicit-trade_9789264251847-en;jsessionid=fHyc5_A1TV9OY5Mx4JQQ4eTJ.ip-10-240-5-25.
[17] "Transparency in the Backbone of Global Supply Chains: Foreign Trade Zones | Royal United Services Institute," accessed December 13, 2021, https://www.rusi.org/explore-our-research/publications/commentary/transparency-backbone-global-supply-chains-foreign-trade-zones/.

Organized criminal groups are consolidating control of multiple markets.[18] For further complication, when responsible officials do not implement or comply with measures to stop the movement of dangerous items, trade can endanger economies – and health. Relevant to this is that trade routes for illicit activity can include multiple types of trade and can involve corrupt people or companies, organized crime, or terrorists. The argument of this paper is just one small subset of the challenges generated by illicit trade. The ongoing lawlessness and involvement of violent non-state actors goes beyond health concerns. These illicit activities create challenges for weak or corrupt states who may not see the importance of battling biological risks when more pressing issues compete for political attention.[19]

Categories of biorisk

We can consider a few specific categories of biorisk due to illicit activity. These categories are accidental, negligent, or intentional/deliberate. Accidental biorisk exposure could include disease introduction, biological invasions (alien species or novel pathogens), wet market and bushmeat consequences, and certain types of environmental crime. Negligent biorisk generation can include examples such as resource depletion, species displacement/eradication, and antibiotic abuse. Intentional/deliberate biorisks are data hacking, intellectual property theft (i.e. vaccines/therapeutics), genome mapping, laboratory theft, and creation or trade in biological weapons.

To better understand the issue of biorisks, an overview of the definition of biosecurity/biosafety is contained here.[20] The National Academies of Science defines biosecurity as "security against the inadvertent, inappropriate, or intentional malicious or malevolent use of potentially dangerous biological agents or biotechnology, including the development, production, stockpiling, or use of biological weapons as well as outbreaks of newly emergent and epidemic disease." [21] Laboratory biosafety includes keeping workers safe from the agents they are working with. Biosecurity aims to keep bio-agents secure from malicious use or

[18] "World Wildlife Report," accessed December 13, 2021, https://www.unodc.org/unodc/en/data-and-analysis/wildlife.html.
[19] "BEYOND CONVERGENCE World Without Order .Pdf," accessed September 13, 2021, https://cco.ndu.edu/Portals/96/Documents/books/Beyond%20Convergence/BEYOND%20CONVERGENCE%20%20World%20Without%20Order%20.pdf?ver=2016-10-25-125406-170.
[20] Gregory D. Koblentz, "Biosecurity Reconsidered: Calibrating Biological Threats and Responses," International Security 34, no. 4 (April 2010): 96–132, https://doi.org/10.1162/isec.2010.34.4.96.
[21] Koblentz, "Biosecurity Reconsidered," April 2010.

theft. Agricultural biosecurity is commonly seen as the methods employed to maintain a disease-free status of farmed plants and animals.

Illicit or unregulated animal trade destined for consumption

Anthropogenic stress such as land degradation, intensive livestock practices and wildlife trade create opportunities for the emergence of infectious diseases.[22] It is known that there are public health concerns due to the increasing human-animal interface and the illegal (or poorly regulated) wildlife markets that comingle wild, captively bred and domestic animals.[23] This legitimate trade can threaten the health of wildlife, livestock, domestic animals, and humans because of the zoonotic infectious disease potential.[24] Parallel to the licit economy, the unregulated or unsustainable exploitation of animals (and habitats) poses threats to the health of humans and animals through the introduction of novel infectious agents that can impact humans and animals.[25] Illicit wildlife and livestock trade are a 'One Health' issue.

Wildlife trade

Wildlife trade can result in public health, environmental, and economic consequences. Combating illicit wildlife activity can prevent the spread of pathogens of public health concern (such as viruses, bacteria, parasite, ectoparasites).[26] There is a danger to humans due to hunting, handling, and cooking some wild animals, so this practice is prohibited is some areas. The Ebola virus is one example of this risk.

Ebola can be linked to chimpanzees, gorillas and bonobos; these primates may be infected through fruit contaminated by bat feces. The human immunodeficiency virus (HIV-1) has a causal link to chimpanzees. HIV-2 originated from Simian Immunodeficiency Virus. Gorillas can possibly transmit simian foamy virus, chickenpox, tuberculosis, measles, rubella, yellow fever, and yaws. African squirrels might be related to outbreaks of monkeypox virus; bushmeat from them can cause

[22] Carlson, Albery, and Phelan, "Preparing International Cooperation on Pandemic Prevention for the Anthropocene."
[23] "Preventing Pandemics through One Health Approach," accessed September 19, 2021, https://www.linkedin.com/pulse/preventing-pandemics-through-one-health-approach-john-e-scanlon-ao/.
[24] "Illegal Wildlife Trade: A Gateway to Zoonotic Infectious Diseases: Trends in Parasitology," accessed December 1, 2021, https://www.cell.com/trends/parasitology/fulltext/S1471-4922(20)30347-0?_returnURL=https%3A%2F%2Flinkinghub.elsevier.com%2Fretrieve%2Fpii%2FS1471492220303470%3Fshowall%3Dtrue.
[25] Cassie Dummett and Arthur Blundell, "ILLICIT HARVEST, COMPLICIT GOODS:," n.d., 81.
[26] "Illegal Wildlife Trade: A Gateway to Zoonotic Infectious Diseases: Trends in Parasitology."

disease transmission to humans.[27] Illegal trade in wildlife meat is estimated to be worth billions of dollars each year.[28] The infectious outcomes from this trade can be deadly. A European Food Safety Authority (EFSA) report regarding Ebola describes the risk: 1) the bushmeat must be contaminated with [Ebola]; 2) the bushmeat has to be (illegally) introduced; 3) the imported bushmeat needs to contain viable virus when it reaches the person; 4) the person has to be exposed to the virus; and 5) the person needs to get infected following exposure.[29]

Initially, there was concern that COVID-19 might have begun in wet markets in the Wuhan Province of China (from bats or pangolins) and this concern has helped to magnify the illegal wildlife trade and the importance for adopting One Health practices.[30] Health and conservation supporters have suggested the stoppage of trade of legal and illegal bushmeat. Some species are banned from being hunted. These animals include primates, pangolins and other forest dwelling animals in Africa and Asia.

A report on recent animal sales in Wuhan China's wet markets reported on seventeen vendor shops. The sales were calculated to involve 36,295 animals (38 wild animal species).[31] Some of these Wuhan market shops had permits from the Wuhan Forestry Bureau (allowing sale of some wild animal species) but none of them had "origin or quarantine certificates, all wildlife trade was fundamentally illegal".[32] Wildlife species are a source of protein, for lower income communities; many argue this is a reasonable source of food.[33] Hunting wild animals can be low cost and can be considered economical for low resourced communities. But, almost 2.25 billion pounds of wildlife is consumed in Africa, leading to extinction trends for some species. [34] Hunting can also take place for trafficking purposes. Bushmeat can be brought into new areas that are far away from where it was poached. The commercial trade market can be difficult to disrupt because there can be multiple government agencies responsible for bushmeat regulations.

At the country border, live animals or meat can be confiscated but only when they are

[27] United Nations, "The Illegal Commercial Bushmeat Trade in Central and West Africa," United Nations (United Nations), accessed September 19, 2021, https://www.un.org/en/chronicle/article/illegal-commercial-bushmeat-trade-central-and-west-africa.
[28] "BBC News - Is Africa's Wildlife Being Eaten to Extinction?," accessed November 30, 2021, http://news.bbc.co.uk/2/hi/science/nature/8877062.stm.
[29] Pablo García-Díaz et al., "The Illegal Wildlife Trade Is a Likely Source of Alien Species," Conservation Letters 10, no. 6 (2017): 690–98, https://doi.org/10.1111/conl.12301.
[30] Chet Trivedy, "Solving the One Health Puzzle," Biodiversity 21, no. 2 (April 2, 2020): 75–82, https://doi.org/10.1080/14888386.2020.1811768.
[31] "Animal Sales from Wuhan Wet Markets Immediately Prior to the COVID-19 Pandemic | Scientific Reports," accessed December 1, 2021, https://www.nature.com/articles/s41598-021-91470-2.
[32] "Animal Sales from Wuhan Wet Markets Immediately Prior to the COVID-19 Pandemic | Scientific Reports."
[33] "A-Wildlifehealth-Conceptnote.Pdf."
[34] Akshat Rathi, "The Illegal Trade in Wild-Animal Meat Could Cause the next Global Pandemic," Quartz, accessed September 19, 2021, https://qz.com/795294/will-illegal-bushmeat-bring-the-next-global-outbreak/.

detected.[35] Corrupt officials might ignore certain trade items if they somehow benefit from it. Food is not the only reason for wet markets. Medicine also drives the demand for consuming wildlife. Rhinoceros horns, bear bile, pangolin scales and tiger parts are used in traditional Chinese medicine, which continues the consumer demand for illegal wildlife. Since 2000 the pangolin is one of the world's most trafficked animals; millions of pangolins are traded in Asia.[36]

The actual consumption of wild animals is not the only pathway for disease transmission. Further research could consider specific animal-to-animal cross species pathways. This is relevant because when non-regulated trade takes place, some species can be housed in a manner that is conducive to disease transmission. As of now, we do know that there is a connection that wet markets and illegal wildlife trafficking results in the transference of diseases from animals to humans (via "consumption, proximity, or mixing of animals or their by-products").[37] Some organizations are focusing on using a One Health approach to identify risks for human health from handling, trading and consuming wildlife and its products; the International Alliance against Health Risks in Wildlife Trade is one example.[38]

Livestock Trade

Illicit farming and food animal trade can contribute to poor animal health status which can lead to a damaged food chain and reduced food security.[39] Unregulated animal trade, farming, transportation, slaughter, or consumption can introduce risks to livestock supply chains. Foods produced for human, or animal consumption are generally assumed to be safe, but the food system is complex due to the design of production and distribution systems. Many food supply chains depend on frameworks such as Hazard Analysis and Critical Control Point (HACCP) to lessen the vulnerabilities and threats.[40] Gaps in biosecurity can occur. Breaches can be disastrous. Vulnerabilities can include natural, accidental, and malicious events. Food disruptions can be caused by insider threats, or deliberate food contamination but these risks are

[35] Rathi.
[36] Christian Nellemann et al., World Atlas of Illicit Flows, 2018, http://globalinitiative.net/wp-content/uploads/2018/09/Atlas-Illicit-Flows-FINAL-WEB-VERSION-copia-compressed.pdf.
[37] A. Alonso Aguirre et al., "Illicit Wildlife Trade, Wet Markets, and COVID-19: Preventing Future Pandemics," World Medical & Health Policy, July 5, 2020, 10.1002/wmh3.348, https://doi.org/10.1002/wmh3.348.
[38] "Home - International Alliance against Health Risks in Wildlife Trade," accessed December 1, 2021, https://alliance-health-wildlife.org/.
[39] Meredith L. Gore et al., "Transnational Environmental Crime Threatens Sustainable Development," *Nature Sustainability* 2, no. 9 (September 2019): 784–86, https://doi.org/10.1038/s41893-019-0363-6.
[40] Paul Robb, "Considering Vulnerabilities, Threats and Gaps in Plant and Food Biosecurity," in Practical Tools for Plant and Food Biosecurity: Results from a European Network of Excellence, ed. Maria Lodovica Gullino et al., Plant Pathology in the 21st Century (Cham: Springer International Publishing, 2017), 1–30, https://doi.org/10.1007/978-3-319-46897-6_1.

toward the end of the food supply chain. The early end of the food supply can face biorisks and devastation due to illicit farming, animal transport or improper trade. Biosecurity measures (e.g., good hygiene, disinfection, dedicated footwear, closed animal herds, quarantines of new animals) help prevent virus introduction into new areas.[41]

There is further convergence of illicit practices regarding food animals. One example of this is the maritime smuggling of drugs and contraband in ships that carry livestock internationally. Livestock ships could be ideal for illegally transporting narcotics, weapons, counterfeit goods, wildlife by-products, and other animal parts. Livestock ships might create logistical challenges for regulators, such as how to care for the animals of impounded ships. Contraband might be hidden in the pens of the animals. Traffickers can hope that enforcement agencies will not search live animal cargo (due to waste products and the offensive olfactory situation).[42] It would not be unreasonable to assume that some of the animals themselves might have false health certificates or origins.[43] This can lead to the spread of livestock disease among animals.

Even non-living animal products can spread disease when laws and regulations are undermined; this can contribute to the spread of animal diseases such as African swine fever (ASF).[44] The ASF disease can spread on fomites (ex. vehicles, equipment, transport cages). The disease can survive for several days in feces or urine. While not infectious to humans, ASF is transmitted through direct contact with infected animals. It can also spread via insects such as ticks, so it can become endemic once it reaches a new host range. The virus can survive several months in processed meat, and several years in frozen carcasses. North America is currently very concerned about the ASF outbreak in Haiti and Dominican Republic. ASF was detected in Haiti in August 2021. Haiti has many backyard farms, and biosecurity is mostly absent. Haiti's plan is to remove the pigs and repopulate with other species (goats, chickens and cows) and will incentivize producers using an investment of US$ 1.27 M. The Haitian government has paid

[41] "African_swine_fever.Pdf," accessed December 12, 2021, https://www.cfsph.iastate.edu/Factsheets/pdfs/african_swine_fever.pdf.
[42] "Live Animal Exports Are Being Used as Cover by Smugglers, Say NGOs | Live Exports | The Guardian," accessed December 12, 2021, https://www.theguardian.com/environment/2021/aug/18/live-animal-exports-are-being-used-as-cover-by-smugglers-say-ngos.
[43] "USDA APHIS | Common Problems Observed on Certificates for Live Animal Movement," accessed December 13, 2021, https://www.aphis.usda.gov/aphis/ourfocus/animalhealth/nvap/NVAP-Reference-Guide/Animal-Movement/common-problems.
[44] "Two Billion and Rising: The Global Trade in Live Animals in Eight Charts | Environment | The Guardian," accessed December 12, 2021, https://www.theguardian.com/environment/2020/jan/20/two-billion-and-rising-the-global-trade-in-live-animals-in-eight-charts.

around US$ 9.31 M to farmers whose animals were slaughtered for eradication.[45] There is no guarantee that farmers will not improperly sell their herds or falsify herd health documents to avoid animal culling. The United States pig market is worth at least $6.5 billion annually; one illicit transport of infected pigs could devastate that market. Biosecurity measures are immensely important.[46]

Deliberate introduction of biological consequences through illicit channels

Infectious diseases are worrisome due to potential purposeful introduction. Biological agents and infectious pathogens can cause global catastrophic risks.[47] One animal disease, Foot and Mouth disease (FMD), is of concern to regulators because of the known devastation it can cause to the food supply and its economic market.[48] The livestock sector is quite vulnerable and has open risks for deliberate and accidental spread of disease.[49] Bioterrorism (defined as the use of biological agents to intentionally produce disease or intoxication in susceptible populations - humans, animals, or plants - to meet terrorist aims) is an illicit activity.[50] Deliberate attacks (involving certain animal or human pathogens) can have national security consequences.[51] Agroterrorism and agrocrime are threats that theoretically would be precipitated by illicit activity in preparation for the attack.

Scientific advances allow for the modification or creation of biological organisms; this biology can help, or harm [52] Biological risks from misuse of life sciences or dual-use biotechnology can include negligence (e.g. counterfeit medication or abuses in the trade of antimicrobials) and intentional risks such as aiding bioterrorism or insider threats to a

[45] "PigProgress - ASF Haiti: Virus Spreads to the North of Peninsula," accessed December 1, 2021, https://www.pigprogress.net/Health/Articles/2021/11/ASF-Haiti-Virus-spreads-to-the-north-of-peninsula-824556E/.
[46] "What Is African Swine Fever and How Does It Spread? | Environment | The Guardian," accessed December 12, 2021, https://www.theguardian.com/environment/2018/oct/24/what-is-african-swine-fever-and-how-does-it-spread.
[47] Terrence M. O'Sullivan, "Disease, Death and Disruption: Globalization, Bioterrorism and the Politics of Catastrophic Infectious Disease Outbreaks" (Ph.D., United States -- California, University of Southern California, 2003), http://www.proquest.com/docview/305294253/abstract/41A2C2EA9513447BPQ/19.
[48] "GAO-19-103, Foot-And-Mouth Disease: USDA's Efforts to Prepare for a Potential Outbreak," accessed September 15, 2021, https://www.gao.gov/assets/gao-19-103.pdf.
[49] Gisela Vasconcelos Gioia et al., "Informing Resilience Building: FAO's Surveillance Evaluation Tool (SET) Biothreat Detection Module Will Help Assess National Capacities to Detect Agro-Terrorism and Agro-Crime," *One Health Outlook* 3, no. 1 (July 19, 2021): 14, https://doi.org/10.1186/s42522-021-00045-8.
[50] Paolo Zucca et al., "The 'Bio-Crime Model' of Cross-Border Cooperation Among Veterinary Public Health, Justice, Law Enforcements, and Customs to Tackle the Illegal Animal Trade/Bio-Terrorism and to Prevent the Spread of Zoonotic Diseases Among Human Population," *Frontiers in Veterinary Science* 7 (2020): 855, https://doi.org/10.3389/fvets.2020.593683.
[51] Dr Christine Blackburn, "Crops, Cattle, and Catastrophe: Securing America's Food Supply," n.d., 20.
[52] David Manheim and Gregory Lewis, "High-Risk Human-Caused Pathogen Exposure Events from 1975-2016," *F1000Research* 10 (August 4, 2021): 752, https://doi.org/10.12688/f1000research.55114.1.

laboratory.[53] Malicious uses have the potential to threaten multiple species.[54] Synthetic biology and advanced biotechnologies can result in modified organisms (to be more virulent, resistant to antibiotics and vaccines). Life sciences can be abused and there could be security implications resulting from biotechnology misuse.[55,56] One example is dual use vaccines (with a mechanism than can harm health) that can find their way to improper buyers and users who may have ill intentions.[57] There exists some concern that hostile states or terrorists could become interested in biowarfare agents.[58] The Commission on the Prevention of Weapons of Mass Destruction Proliferation and Terrorism claimed, "the United States should be less concerned that terrorists will become biologists and far more concerned that biologists will become terrorists".[59]

These illicit commodity and biological concerns are founded, since in the past, non-state armed groups and drug cartels have generated income streams from natural resources and biology-based markets (such as growing opium, and illegal logging or mining).[60] One group (FARC) funded themselves through commodities of cattle and agricultural products (as well as oil and gold).[61] ISIS has made it known that they are more than willing to support the drug trade that results in the harm to their enemies. [62] Of greatest concern, an ideological based terror group could design a biological attack by gaining access to a disease agent, or a private citizen worker could be coerced to aid in such an illicit act. Organized criminal groups and terrorists are open to new business opportunities as they exploit crises and adopt new technologies.[63]

Policy Solutions

In Europe, one method to combat these biological threats is the Bio-crime model of cross-border cooperation, which includes public health, law enforcement and customs agencies

[53] Thomas E. Engells, "The Insider Threat -- a New Aspect of Biosecurity," *Journal of Healthcare Protection Management* 29, no. 2 (August 2013): 16–25, http://mutex.gmu.edu/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=tsh&AN=90208576&site=ehost-live.
[54] "Login | The National Academies Press," accessed December 1, 2021, https://www.nap.edu/login.php?record_id=24890.
[55] Koblentz, "Biosecurity Reconsidered," April 2010.
[56] "Select Agents and Toxins | Federal Select Agent Program," September 10, 2020, https://www.selectagents.gov/sat/index.htm.
[57] Jonas B. Sandbrink and Gregory D. Koblentz, "Biosecurity Risks Associated with Vaccine Platform Technologies," Vaccine, February 25, 2021, https://doi.org/10.1016/j.vaccine.2021.02.023.
[58] "Biological Threat Assessment: Is the Cure Worse Than the Disease? | Arms Control Association," accessed February 16, 2021, https://www.armscontrol.org/act/2004-10/features/biological-threat-assessment-cure-worse-disease.
[59] "Commission on the Prevention of Weapons of Mass Destruction Proliferation and Terrorism - UNT Digital Library," accessed December 13, 2021, https://digital.library.unt.edu/ark:/67531/metadc26020/.
[60] Dummett and Blundell, "ILLICIT HARVEST, COMPLICIT GOODS:"
[61] Nellemann et al., World Atlas of Illicit Flows.
[62] Louise I. Shelley, "'Illicit Trade and Terrorism.' Perspectives on Terrorism," Perspectives on Terrorism 14, no. 4 (2020): 7–20, http://www.jstor.org/stable/26927661.
[63] "Security Council, Adopting Resolution 2195 (2014), Urges International Action to Break Links between Terrorists, Transnational Organized Crime | Meetings Coverage and Press Releases," accessed September 24, 2021, https://www.un.org/press/en/2014/sc11717.doc.htm.

using the International Police and Custom Cooperation Centres (IPCCCs).[64] The US government also recognizes that biorisks and infectious disease can become national security concerns.[65] Therefore, laws and enforcement of illicit trade of biological risk categories should be enforced to their full extent. Intelligence agencies should make better attempts to find and disrupt illicit activity where biological consequence is possible – such as in border and transport law enforcement. This might be accomplished through increased public awareness, non-corrupt surveillance at ports and borders, inspection of transported animals (livestock and wildlife), and the proper enforcement of national and international regulations. Also, implementing the suggestions in the International Health Regulations and the Global Health Security Agenda could assist the United States in preventing disease occurrences.[66] The current global health security framework must become committed to halting the illicit trade that can result in biological consequences. The path to strengthening global health security should include solid illicit trade combat strategies and this can be combined with already existing solutions. For example, the Global Health Security Index makes note of illicit trade problems and suggests a whole-of-society approaches to health security - which goes beyond the potential reach of individual sectors.[67]

Biological and health security threats exist on a spectrum. A firm solution to animal disease control is not yet apparent as many authors offer novel ideas. Some solutions include amending the 1973 Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) treaty to control traded animal and plants species.[68] Other ideas include regulating wildlife markets, mandating biodiversity buffers, and proposing an 'International Pandemics Treaty' to obligate commitments that could prevent pathogen emergence.[69] A pandemic treaty should be a global agreement and include very robust language to combat the sources of biorisks that are caused by illicit trading.[70]

[64] Zucca et al., "The 'Bio-Crime Model' of Cross-Border Cooperation Among Veterinary Public Health, Justice, Law Enforcements, and Customs to Tackle the Illegal Animal Trade/Bio-Terrorism and to Prevent the Spread of Zoonotic Diseases Among Human Population."
[65] "DARPA: Defense Advanced Research Projects Agency 1958-2018 by Faircount Media Group - Issuu," accessed December 12, 2021, https://issuu.com/faircountmedia/docs/darpa_publication/1?ff.
[66] Tracey V - APHIS Dutcher, "APHIS' American Rescue Plan (ARP) Surveillance Program: Strategic Framework," n.d., 6.
[67] Sanjana J Ravi et al., "The Value Proposition of the Global Health Security Index," BMJ Global Health 5, no. 10 (October 2020): e003648, https://doi.org/10.1136/bmjgh-2020-003648.
[68] "Wildlife Regulation, 'One Health' Keys to Avert More Pandemics," Cornell Chronicle, accessed September 19, 2021, https://news.cornell.edu/stories/2021/02/wildlife-regulation-one-health-keys-avert-more-pandemics.
[69] "Preventing Pandemics through One Health Approach."
[70] "No Future But A Shared Future | Think Global Health," accessed December 1, 2021, https://www.thinkglobalhealth.org/article/no-future-shared-future.

A One Health systems approach should be used against the convergence of illicit biorisks.[71] One policy option is to incorporate the concept of One Biosecurity.[72] This idea is the consideration for plant, animal, human, and environmental health as it integrates biosecurity threats and uses and interdisciplinary approach against biorisks but can be improved to account for illicit activity disruption.[73] The stakeholders of health threat assessment requires many professions; such as medicine, veterinary, crop science, anti-crime, intelligence, international security, and public health.[74]

Therefore, by taking seriously the nature of biorisks, there could be interruption of future or concurrent illicit activity. Also, transnational organized-criminal groups sometimes exploit natural resources and natural commodies and reply on an environmental criminal enterprise in conflict zones.[75] These geographic areas quite frequently have corrupt leadership, which can aid in the existence of illicit actors. The financial flows embedded in these illicit channels should be traced and used to locate the perpetrators of these activities. Many conflicts, including terrorism related, are funded by organized crime through the revenue gained by the illicit trade of natural resources.[76]

Conclusion:

The risks reviewed here include deliberately introduced disease outbreaks, natural disease outbreaks, outbreaks caused by negligence in the food supply trade and the consequences of emerging technologies. [77] Certain illicit activity can exacerbate biorisks unintentionally so policies should reflect the importance of these supply chain risks. Disease emergence due to illicit trade should be listed as a top concern for law enforcement, intelligence services and trade enforcement agencies. The convergence of illicit trade can frequently involve licit company corruption, political corruption, organized crime, terrorism, and money laundering.[78] More importantly, many illicit trade routes are used for many types of illicit goods movement.

Trade is fast and more connected than ever. In current our globalized economy the ease of connection through internet and digital financial flows can aid in the trade of goods that can

[71] Ross D. Arnold and Jon P. Wade, "A Definition of Systems Thinking: A Systems Approach," Procedia Computer Science, 2015 Conference on Systems Engineering Research, 44 (January 1, 2015): 669–78, https://doi.org/10.1016/j.procs.2015.03.050.
[72] Philip E. Hulme, "One Biosecurity: A Unified Concept to Integrate Human, Animal, Plant, and Environmental Health.," Emerging Topics in Life Sciences 4, no. 5 (2020): 539–49, http://dx.doi.org.mutex.gmu.edu/10.1042/ETLS20200067.
[73] Hulme.
[74] "Health Security Intelligence: Engaging across Disciplines and Sectors."
[75] Gore et al., "Transnational Environmental Crime Threatens Sustainable Development."
[76] Nellemann et al., World Atlas of Illicit Flows.
[77] "Health Security Intelligence: Engaging across Disciplines and Sectors," accessed December 9, 2021, https://www.tandfonline.com/doi/full/10.1080/02684527.2020.1750166.
[78] "Illicit Trade."

cause health harm as lawlessness proliferates.[79] Beyond 2021, we can hope that lessons will be learned due to surviving a global pandemic.[80] Holistic approaches are required for the prevention and control of emerging and resurging diseases. The complex (and sometimes illicit) interconnections among humans, domestic animals, and wildlife can share threats of disease - to individuals, food supplies, economies, and the functioning ecosystems that support all the species on Earth.[81]

[79] H. Richard Friman and Peter Andreas, *Illicit Global Economy & State Power*, "Introduction: International Relations and the Illicit Global Economy," n.d.
[80] "One World - One Health > About Us > Mission > The 2019 Berlin Principles on One Health," accessed December 6, 2021, https://oneworldonehealth.wcs.org/About-Us/Mission/The-2019-Berlin-Principles-on-One-Health.aspx.
[81] "One World - One Health > About Us > Mission > The 2019 Berlin Principles on One Health."

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