Article

The convergence of environmental crime with other serious crimes: Subtypes within the environmental crime continuum

Daan P. van Uhm [iD] and Rick C.C. Nijman
Utrecht University, The Netherlands

Abstract
The rising global scarcity of natural resources increasingly attracts transnational criminal organizations. Organized crime syndicates diversify into the lucrative business of tropical timber, endangered species, and natural minerals, alongside their traditional activities. The developing interconnectedness between environmental crime and other serious crimes shows that traditional lines of separation are no longer appropriate for understanding and dealing with the increasing complexities of organized crime. Therefore, this article aims to analyse the nexus between environmental crime and other serious crimes through cluster analyses to identify subtypes of organized crime groups that have diversified into the illegal trade in natural resources. The two-step cluster algorithm found a cluster solution with three distinct clusters of subtypes of criminal groups that diversified into the illegal trade in natural resources in various ways: first, the Green Organized Crime cluster, with a high degree of diversification and domination; second, the Green Opportunistic Crime cluster, with flexible and fluid groups that partially diversify their criminal activities; and, third, the low-level diversifiers of the Green Camouflaged Crime cluster, shadowing their illegal businesses with legitimate companies. The three clusters can be related to specific stages within the environmental crime continuum, albeit with nuances.

Corresponding author:
Daan P. van Uhm, Willem Pompe Institute for Criminal Law and Criminology, Utrecht University, Newtonlaan 231, Utrecht, 3584 BH, The Netherlands.
Email: d.p.vanuhm@uu.nl

Introduction

Environmental crime has become a significant new form of organized criminal activity, with disastrous impacts on the environment and costs for future generations (OECD, 2016; Walters, 2014; White, 2011). The rising global scarcity of natural resources increasingly attracts transnational criminal organizations, which rapidly shift from 'traditional' organized crime activities, such as drug or human trafficking, to the illegal trade in natural resources (Elliott, 2009; Nellemann et al., 2016). For example, organized crime syndicates[1] diversify into the lucrative business of tropical timber, endangered species, and natural minerals alongside their traditional activities (Interpol, 2016; Miklaucic and Brewer, 2013; UNODC, 2012).[2]

The developing interconnectedness between environmental crime and other serious crimes shows that traditional lines of separation are no longer appropriate for understanding and dealing with the increasing complexities of organized crime (Interpol, 2015; Shelley, 2017). Therefore, the classic image of hierarchical well-structured organized crime specializing in one kind of criminal activity appears to be too narrow (see Paoli, 2002). In the context of vanishing borders, improved communication techniques, advanced transportation methods, and the growth of cyberspace, new collaborations, alliances, and fluid criminal networks are developed (Aas, 2013; Galeotti, 2014; Morselli, 2009).[3] These criminal networks interact, cut across borders, infiltrate illicit markets, penetrate fragile governments, and threaten security and safety around the world (Morselli, 2009; Varese, 2011).

The crimes committed by such groups are considerably more complex logistically,[4] the groups vary in terms of socioeconomic and ecological opportunity structures, and the actors have different characteristics and criminal careers (for example, Bovenkerk, 2000; Kleemans and De Poot, 2008). The crime groups may differ in 'size', from small groups of individuals retrieving contraband primarily for their personal or group use, to groups devoted to generating profit from their criminal activities (Morselli, 2009; Paoli, 2002), in 'crime range', from groups involved in a variety of contraband to groups solely involved in one particular crime (Shelley, 2017; Siegel and Van de Bunt, 2012), but also in 'crime combinations', for instance smuggling both weapons and gold, or trafficking reptiles and cocaine together (Lichtenwald et al., 2009; Miklaucic and Brewer, 2013).

Some crime organizations are able to make a 'career shift' to new businesses and 'infiltrate' new markets in order to adapt to changing socioeconomic and situational conditions (Kleemans and De Poot, 2008; Von Lampe, 2015), whereas other groups 'dominate' new markets completely (Cressey, 1969; Varese, 2011). Furthermore, crime groups may benefit from existing illegal infrastructures in the areas where they operate (Albanese and Reichel, 2014; Siegel et al., 2003). For example, 'access to smuggling routes', 'smuggling methods' or 'local corruption' established for particular crimes may also facilitate different forms of crime (Naylor, 2004; Van Duyne, 1996). The groups may also use their legitimate infrastructure to 'camouflage' contraband with legitimate goods; the illegal activities are hidden in plain sight – for instance, cocaine concealed in timber (Block and Chambliss, 1981; Passas, 2002).[5] Instead of money, some use contraband such as gold as 'barter trade' (for example for drugs or weapons), whereas other

crime groups have 'multiple trade lines' simultaneously (Lin, 2005; South and Wyatt, 2011; Van Uhm, 2016a), which illustrates myriad forms of crime convergence.

This raises important questions: How do criminal groups diversify their criminal activities into the illegal trade in natural resources? What are the features of these criminal organizations and what types of diversifying crime groups can we distinguish? This article proposes a novel understanding of the changing face of organized crime by approaching environmental crimes in relation to other serious crimes.

Theoretical framework: The environmental crime continuum

In order to understand the past, current, and potential future evolution of organized crime into the illegal trade in natural resources, Figure 1 presents the environmental crime continuum (developed by Van Uhm, 2018a), based on theoretical concepts from criminology, environmental studies, and political science. This model was originally developed for understanding the diversification of organized crime into the illegal trade in natural resources (Van Uhm, 2018a), but the model could also be used to understand general developments of organized crime and links to other serious crimes. In this study, we apply the model to environmental crime and nexuses with other serious crimes.

Five points are situated on the environmental crime continuum. Each single point displays a form of convergence between organized crime (situated on the far left) and environmental crime (situated on the far right). The level of diversification of organized crime into environmental crime increases during the stages gradually: from minor diversification of organized crime groups, expanding their illegal activities with environmental crimes to a limited extent based on alliances with environmental crime groups (1) to overall domination over environmental crimes (5). Within the scope of this article, the model of various relationships between organized crime and environmental crime may assist our theoretical understanding of the convergence between environmental crime and other serious crimes.
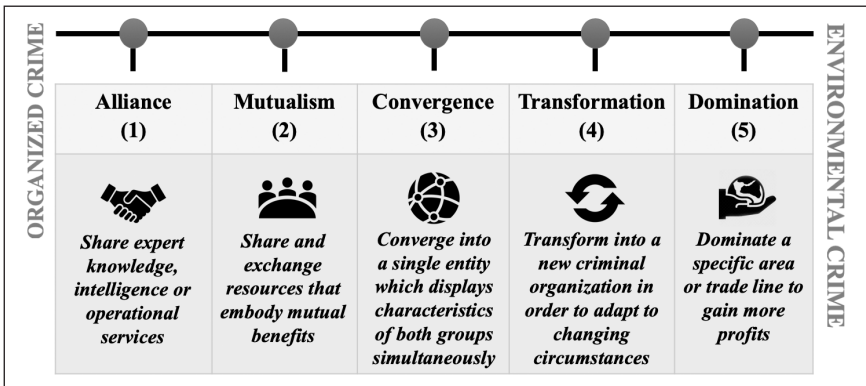

Alliance (1)	Mutualism (2)	Convergence (3)	Transformation (4)	Domination (5)
Share expert knowledge, intelligence or operational services	Share and exchange resources that embody mutual benefits	Converge into a single entity which displays characteristics of both groups simultaneously	Transform into a new criminal organization in order to adapt to changing circumstances	Dominate a specific area or trade line to gain more profits

Figure 1. The environmental crime continuum.

First, alliances between organized crime groups and environmental crime groups may be established for expert knowledge or operational services akin to social relationships within legitimate business settings (Gounev and Ruggiero, 2012; Makarenko, 2004: 131). The nature of alliances may vary: it can include one-off, short-term relationships or long-term relationships (Morselli, 2009; Paoli, 2003). Alliances are established to share information such as communication technologies and counter-surveillance techniques, or to provide access to smuggling routes. For instance, alliances arrange for minerals to be smuggled along routes established for other types of illicit commodities (Europol, 2011; Nellemann et al., 2014). Therefore, the first stage reflects minor diversification of crime groups, extending their illegal activities into environmental crimes to a limited degree, based on alliances with environmental crime organizations.

Second, more sophisticated mutual relationships between organized crime groups and environmental crime groups may be established for the long-standing exchanging and sharing of natural resources, the stopping of mutual adversaries, and the spread of crime (Felson, 2006: 185; Moreto et al., 2019). This may involve symbiotic relationships that include both illegitimate and legitimate activities for conscious mutual benefits (Passas, 2002: 23). Crime mutualism embodies barter trade such as wildlife being exchanged for drugs and stolen cars, or camouflage, when a legitimate company is used to shield illegal trafficking (Austrac, 2010; Chiszar et al., 2002; South and Wyatt, 2011).[6] Compared with stage (1), stage (2) involves a higher degree of diversification, as the organized crime groups become increasingly involved in environmental crime through crime mutualism.

Third, environmental crime organizations and other criminal organizations could converge into a single entity that displays characteristics of both groups simultaneously (Miklaucic and Brewer, 2013: xiv). In this scenario, the crime groups might eventually converge completely and become one and the same in the middle of the continuum (Makarenko, 2001: 22–4). This represents the confluence of different forms of illegal activities as well as the ability to diversify (Shelley and Kinnard, 2018: 117). An example would be a criminal enterprise involved in both human trafficking and fisheries, or a reptile trader involved in the supply of cocaine utilizing multiple trade lines (Lichtenwald et al., 2009; UNODC, 2011; Van Uhm, 2018b). Stage (3) displays hybrid and multifaceted crime groups with the capability to diversify into environmental crime and retain their traditional crime characteristics.

Fourth, criminal groups may transform into entrepreneurial organizations in order to adapt to changing circumstances (Dishman, 2001; Williams, 1998). In this metamorphosis, the organized crime groups decide to depart from their traditional activities and reshape their features in order to infiltrate a new criminal market (Bovenkerk and Chakra, 2004: 5), in this case the environmental crime market. This career shift changes the way that the criminal groups perform their operations because they become fixated so keenly on one criminal activity that they drop the other altogether. An example is the infiltration of criminal organizations into the illegal trade in minerals for the expanding computer and cell-phone markets (Sutherland, 2011). In stage (4), the ultimate aims and motivations of the crime group have actually changed in order to diversify into the illegal trade in natural resources.

Finally, criminal organizations may start to dominate a specific area or trade line (Cressey, 1969: 28). By monopolizing elements of trade lines or by controlling the

entire supply chain through the use of violence, intimidation, or extortion, criminal groups may effectively achieve control, reputation, and authority (Albanese, 1985; Varese, 2011). In contrast to the symbiotic relationships between crime groups in the earlier the stages (1, 2 and 3), the latter two stages (4 and 5) display antithetical relations in which there is competition between criminal groups vying for market shares (Passas, 2002; Van Uhm and Moreto, 2018). The caviar trade serves as an example as it has reportedly been controlled by the Russian mafia competing with local fishers (Van Uhm and Siegel, 2016). In this final stage, the organized crime groups dominate environmental crime markets completely.

Methodology and geographical context

To get insights in the subtypes of organized crime groups that diversify into the illegal trade in natural resources, 106 international environmental crime cases with links to other serious crimes were collected by using convenience sampling ($N=106$). This is a type of non-probability sampling where subjects are selected because of their convenient accessibility and proximity to the researcher rather than because they are representative of the population (Davies and Francis, 2011; Maxwell, 2005). Data on environmental crime cases were retrieved directly from the courts as well as from several online case law databases (for example, Sherloc case law database) or reconstructed by data from media articles from around the world.

The sample includes cases between 1980 and 2018 that were available and accessible by using search strategies in online case law databases and on the Internet. Specific keywords, such as 'drugs and wildlife', 'timber and weapons', or 'gold and human trafficking', among others, were used to track down the environmental crime cases. In addition, international police reports (for example, Interpol, 2015, 2016, 2018) and UN reports (for example, Nellemann et al., 2014; Nellemann et al., 2016) were scrutinized and environmental crime experts were asked for relevant convergence cases to be included in the sample. The types of crimes in the cases mainly included trafficking offences, such as timber, wildlife, fish, and mineral trafficking with links to the trade in drugs, humans, and weapons. Other offences included those relating to corruption, forgery, murder, and money laundering. Therefore, single cases in this study frequently include multiple offences. However, the sample of collected crime cases reflects only a fraction of the crimes because a large part of the crimes remains unreported or undiscovered, the so-called dark number (Coleman and Moynihan, 1996).[7]

Figure 2 illustrates the geographical distribution of the origin of the international environmental crime cases. The most important origins of illegal trade in the collected cases are Africa ($N=31$, 29.2 percent), South America ($N=24$, 22.6 percent), and Asia ($N=22$, 20.8 percent), and the most frequently occurring destinations are Asia ($N=39$, 36.8 percent), North America ($N=21$, 19.8 percent), and Europe ($N=15$, 14.2 percent).[8] The majority of the wildlife nexus cases come from Africa (42.9 percent), many of both the minerals (66.7 percent) and the fish (34.8 percent) cases link to South America, and the greater part of the timber convergence cases (50.0 percent) were from Asia. Most environmental crime cases with links to drugs originated in South America (46.0 percent), whereas human trafficking cases were mainly linked to Asia (46.2 percent), and
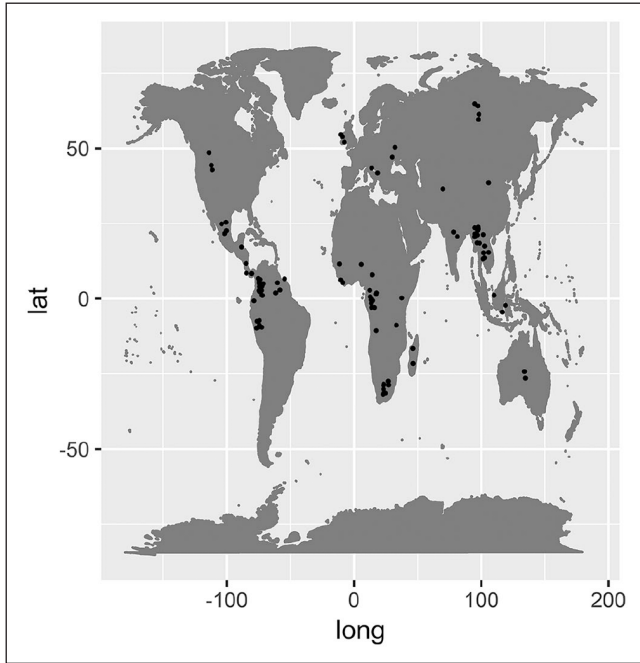
Figure 2. Geographical distribution of international environmental crime cases by origin country.
Note: The map is created with statistical software package *R*. Jittering, the act of adding random noise to data, has been used to prevent overplotting in the statistical graphics.

the weapon trade in this analysis almost always comes from Africa (86.7 percent); 80.8 percent of the origin countries were below the poverty line[9] and more than half of the cases (51.5 percent) were from the 17 megadiverse countries[10] that contain the majority of Earth's species and high numbers of endemic species.[11]

Relatively many cases originate from three areas of the world that are well known for their criminal reputation: first, the Golden Triangle ($N=15$, 14.9 percent) (Myanmar, Laos, Thailand, and China), one of the most underdeveloped areas in Southeast Asia and notorious for its booming opium trade (Chin, 2009); second, the biodiversity hotspot[12] the Congo Basin ($N=10$, 9.9 percent), an important conflict area in Central Africa (Nellemann et al., 2010); third, the drug-smuggling corridor the Darién Gap ($N=14$, 13.9 percent), a remote swath of jungle on the Colombia–Panama border where criminal organizations are active and where overlaps with environmental crime increasingly occur (GITOC, 2016).[13]

Data

The 106 international environmental crime cases with links to other serious crimes were coded on more than 30 variables. The data were coded using a standardized item list partly based on concepts from the environmental crime model (Van Uhm, 2018a).[14] The cases were independently coded by two assessors and, in order to increase consistency, the

coding was compared for agreements, which contributed to inter-rater reliability (Maxfield and Babbie, 2018: 126). Although the contextual variables (for example, origin country; biodiversity hotspot; poverty level) provide informative geographical background, for the cluster analysis a set of 12 other variables were selected. The operational characteristics and crime group demography variables were selected based on concepts of the theoretical framework and are expected to be related to the diversification of crime groups into the illegal trade in natural resources. The variables were directly associated with the operational characteristics of the crimes and the crime group demography (Table 1).

Nine dichotomous variables were allocated to the operational characteristics of the crimes based on the environmental crime continuum. The first two variables represent internal group dynamics such as operational services or expert knowledge being used for the illegal trade in natural resources. The crime groups may use 'similar smuggling methods' ($N=76$, 72 percent) established for other types of illicit commodities. This variable refers to the same smuggling methods, for instance smuggling both gold and drugs hidden in the trunk of a car by the same crime group (FIP, 2017). In addition, the groups may have 'access to smuggling routes' ($N=101$, 95 percent) established for other types of illicit commodities. This variable refers to established drugs, weapons, or human smuggling routes that are being used for the illegal trade in natural resources, based on literature – for example, the World Atlas of Illicit Flows (Interpol, 2018) or the Atlas of Trafficking in Southeast Asia (Chouvy, 2013).

The next four variables reflect the different trade forms and modi operandi in the environmental crime cases. The variable 'barter trade' ($N=23$, 22 percent) shows natural resources that are being exchanged for other contraband such as drugs or weapons, while 'multiple tradelines' ($N=79$, 75 percent) is related to more than one illegal trade line controlled by the same crime group. The variable 'camouflage' ($N=32$, 30 percent) refers to illegal trade being covered by legitimate trade (Van Uhm, 2018b), and 'local corruption' ($N=48$, 45 percent) takes place when local officials are being bribed by the criminal group (Knutsen et al., 2017).

The external group dynamics are displayed by the following three variables. 'Infiltration' ($N=76$, 72 percent) happens when a crime group infiltrates a new environmental market. For instance, Chinese Triads became increasingly involved in the illegal trade in abalone in South Africa in the 2000s (De Greef and Raemaekers, 2014). A 'career shift' to environmental crime ($N=40$, 38 percent) takes place when the perpetrators were active in other serious crimes before but become so fixated on one environmental crime activity that they drop the other crime(s) – for example, perpetrators of rhino horn trafficking that were previously convicted for drug trafficking but recently started to trade in rhino horns owing to the high value on the black market (Europol, 2012). Lastly, the variable 'domination' ($N=26$, 25 percent) shows the domination over a specific area (or trade line) of environmental crime in order to adapt to changing socioeconomic and ecological circumstances – for example, when an organized crime group becomes involved in environmental crime and is known, based on the literature, to dominate that particular region, such as the Gulf Clan's involvement in gold extraction in the Darién Gap of Colombia (for example, FIP, 2017).

The three crime group demography variables (two ordinal and one nominal) correspond to the characteristics of the criminal network in the cases: 'group size' (0=small

Table 1. Environmental crime variables (*N*=106).

Variables	Categories	Count	Percent
Operational characteristics			
Similar smuggling methods (1)		76	71.7
Access to smuggling routes (1)		101	95.3
Barter trade (1)		23	21.7
Multiple tradelines (1)		79	74.5
Camouflage (1)		32	30.2
Local corruption (1)		48	45.3
Infiltration (1)		76	71.7
Career shift (1)		40	37.7
Domination (1)		26	24.5
Crime group characteristics			
Group size	Small (3–5)	20	18.9
	Medium (6–10)	38	35.8
	Large (>10)	48	45.3
Crime range	Small (1–2)	36	34.0
	Medium (3–5)	26	24.5
	Large (>5)	44	41.5
Environmental type & other serious crime type	Wildlife & drugs	31	29.2
	Wildlife & humans	4	3.8
	Wildlife & weapons	7	6.6
	Fish & drugs	15	14.2
	Fish & humans	4	3.8
	Fish & weapons	1	0.9
	Minerals & drugs	9	8.5
	Minerals & humans	4	3.8
	Minerals & weapons	4	3.8
	Timber & drugs	12	11.3
	Timber & humans	1	0.9
	Timber & weapons	3	2.8
	Unclassified	11	10.4

'3–5 members'; 1=medium '6–10 members'; 2=large '>10 members') and 'crime range' (0=small '1–2 serious crimes'; 1=medium '3–5 serious crimes'; 2=large '>5 serious crimes')[15] identified in the cases and, finally, the 'environmental type and other serious crime type' variable. This latter nominal variable includes fish (*N*=20), minerals (*N*=17),[16] timber (*N*=16), and wildlife (*N*=42) trafficking in combination with trade in drugs, humans, weapons, and other unclassified illegal trades (for example, cigarettes, cars).

Clustering procedure

A cluster analysis was performed to present the 106 collected environmental crime cases in groups by using SPSS version 25.0 (IBM Corp., 2017). Cluster analysis summarizes

data into meaningful groups wherein the objects within the same group are more or less the same and objects between groups differ (Everitt et al., 2011: 13). It is an unsupervised method that aims to discover groups, instead of classifying objects into pre-specified groups (Everitt et al., 2011: 7). This makes cluster analysis an explorative technique, which cannot be used to formally test hypotheses. However, it can be applied to create subtypes of environmental crime cases that might give new insights into how environmental crime organizations are related in different ways to other serious crimes.

Examples of cluster analyses used to understand criminal networks include the role of (social) ties that bind criminal networks (Malm et al., 2009), the organization structures of human trafficking (Van der Laan, 2012), and the effects of drug cartel violence (Chiu and Turvey, 2015). Cluster analyses were also used to understand types of perpetrators, including serial killers (Taylor et al., 2012), sexual offenders (Goodwill et al., 2016), firesetters (Dalhuisen et al., 2017), and homicide offenders (Pajevic et al., 2017). However, no cluster analyses have been performed to date to identify subtypes of organized crime groups that diversified into the illegal trade in natural resources.

The performance of a particular clustering method depends on the type of data used (Everitt et al., 2011: 257). The environmental crime data of this study consist of a mix of symmetrical binary nominal and ordinal variables. An appropriate clustering algorithm that can handle mixed data types is the two-step clustering algorithm (Everitt et al., 2011). The first step of two-step clustering is to create pre-clusters by making a cluster feature tree, which is useful when large datasets are clustered (Bacher et al., 2004). These pre-clusters are used as new observations in the second step, where an agglomerative hierarchical procedure is performed. A model-based approach is used on the assumption that continuous variables are normally distributed and categorical variables are multinomially distributed within clusters. Based on the Akaike information criterion (AIC) and the Schwarz's Bayesian Inference criterion (BIC), the best clustering method is determined along with the number of clusters (Sarstedt and Mooi, 2014). Thereafter, ratios of log-likelihood distances between a k cluster solution and a k–1 solution are used to determine the final number of clusters.[17]

Cluster algorithms will always find clusters, even when there is no clear underlying structure in the data (Tan et al., 2013). In other words, even with random generated data without underlying groups, the algorithm will reveal clusters, since the algorithm is optimized to do so. Therefore, it is important to evaluate cluster solutions. Kaufman and Rousseeuw (1990: 83) introduced the average silhouette width (ASW) as an absolute measure. The silhouette of an observation is the average distance to the observations of its own cluster compared with the average distance to the observations of the closest cluster. The mean of all silhouettes constitutes the ASW, which has a range from −1 to 1. Values of 0.5 or higher are an indication of a reasonable structure in the data (Kaufman and Rousseeuw, 1990; IBM Corp., 2017).

Results

The two-step cluster algorithm found a cluster solution with three distinct clusters. The resulting clusters 1, 2, and 3 contained 42, 38, and 26 cases, which corresponds to 39.6 percent, 35.8 percent, and 24.5 percent of the collected cases respectively. The average

silhouette of this solution is 0.5, which is an indication of a reasonable structure in the data (Kaufman and Rousseeuw, 1990). The two-step cluster solution had a ratio of 1.62[18] and included all the 106 collected environmental crime cases. The algorithm gives the same cluster solution when using AIC and BIC and, when the order of cases was changed, results did not change substantially. Moreover, an agglomerative hierarchical algorithm (average linkage) with dummy variables results in a similar cluster solution as with the two-step algorithm.[19]

Table 2 shows the descriptive statistics of the three-cluster solution produced by the two-step cluster algorithm.[20]

Cluster 1: Green Organized Crime

Cluster 1 contains 42 cases and we call it the *Green Organized Crime* cluster. This cluster is linked to large criminal groups (100.0 percent) mainly involved in drugs and weapons trade that diversify into minerals, wildlife, and timber trafficking and use 'similar smuggling methods' (100.0 percent). The cluster presents high levels of diversification into the illegal trade in natural resources illustrated by 'multiple trade lines' (100.0 percent), 'infiltration' (95.2 percent), and a 'career shift' to environmental crime (83.3 percent). For instance, members of the Central and South American drug cartels – such as the Gulf Clan – shifted to the trade in illegal minerals, in particular gold (Case nos 15, 25, 48, 64, 84, 96), and members of the Irish mobile organized crime group, the Rathkeale Rovers, transformed their activities from drugs, cigarettes, and counterfeit into robbing museums of their rhino horns all over Europe (for example, Case nos 17, 42). In addition to 'access to smuggling routes' (100.0 percent) being used by the criminal groups to perform their new environmental crime activities, this cluster involves almost all cases of 'barter trade' (40.5 percent), which illustrates the convergence between traditional crime groups and environmental crime groups – for example, Congolese organized crime groups that diversify their illegal activities into minerals, timber, and wildlife to exchange it for weapons (Case nos 3, 12, 13, 46, 70, 86, 100), or Chinese Triads in South Africa that barter abalone for methamphetamine (Case nos 44, 45, 58, 76). Remarkably, these networks have a large 'crime range' (95.2 percent) and operate mainly in the underworld without using legitimate companies to 'camouflage' (2.4 percent) their illegal activities. To facilitate trafficking, 'local corruption' (97.6 percent) therefore plays a fundamental role. In more than half of the cases, the criminal groups not only transform their activities into the illegal trade in natural resources but fully 'dominate' (54.8 percent) a specific trade line or area. This cluster predominantly includes the types 'wildlife & drugs', 'wildlife & weapons', 'minerals & drugs', 'minerals & weapons', and 'timber & weapons'.

Cluster 2: Green Opportunistic Crime

Cluster 2 contains 38 cases and displays what we call the *Green Opportunistic Crime* cluster. This cluster is mainly linked to medium (60.5 percent) sized criminal groups involved in human trafficking and drugs in combination with wildlife, fish, minerals and timber, by using 'similar smuggling methods' (86.8 percent). Noticeably, within this cluster most 'unclassified' cases are included, such as 'wildlife & cars', 'timber & fuel',

Table 2. Two-step cluster solution with three clusters.

Variables	Categories	Cluster 1	Cluster 2	Cluster 3	
		n = 42	n = 38	n = 26	χ^2
		Within cluster percentage			Value
Operational characteristics					
Similar smuggling methods (1)		100.0	86.8	3.8	79.86**
Access to smuggling routes (1)		100.0	100.0	80.8	16.15**
Barter trade (1)		40.5	13.2	3.8	15.23**
Multiple tradelines (1)		100.0	92.1	7.7	81.72**
Camouflage (1)		2.4	18.4	92.3	65.51**
Local corruption (1)		97.6	15.8	3.8	77.79**
Infiltration (1)		95.2	92.1	3.8	78.26**
Career shift (1)		83.3	13.2	0.0	62.69**
Domination (1)		54.8	5.3	3.8	34.37**
Crime group characteristics					
Group size	Small (3–5)	0	31.6	30.8	84.14**
	Medium (6–10)	0	60.5	57.7	
	Large (>10)	100.0	7.9	11.5	
Crime range	Small (1–2)	0	42.1	76.9	94.61**
	Medium (3–5)	4.8	50.0	19.2	
	Large (>5)	95.2	7.9	3.8	
Environmental type & other serious crime type	Wildlife & drugs	28.6	36.8	19.2	80.28**
	Wildlife & humans	2.4	7.9	0.0	
	Wildlife & weapons	16.7	0.0	0.0	
	Fish & drugs	4.8	2.6	46.2	
	Fish & humans	0.0	10.5	0.0	
	Fish & weapons	0.0	2.6	0.0	
	Minerals & drugs	14.3	2.6	7.7	
	Minerals & humans	2.4	5.3	3.8	
	Minerals & weapons	9.5	0.0	0.0	
	Timber & drugs	9.5	7.9	19.2	
	Timber & humans	0.0	2.6	0.0	
	Timber & weapons	7.1	0.0	0.0	
	Unclassified	4.8	21.1	3.8	

**p < .001 (two-sided).

and 'wildlife & tobacco'. In contrast to the *Green Organized Crime* cluster, the criminal groups partially diversify their criminal activities with a small or medium crime range (42.1 percent and 50.0 percent respectively), but clearly lack a 'career shift' (13.2 percent) and 'domination' (5.3 percent) over a specific area of environmental crime. For example, opportunistic criminal groups from Madagascar that smuggle tortoises together

with drugs (Case nos 33, 35) or European crime groups that smuggle caviar and timber along with cigarettes or cars (Case nos 9, 62, 101) show rather flexible and fluid operations instead of well-organized businesses. Even though they use 'multiple trade lines' (92.1 percent), they rarely perform 'barter trade' (13.2 percent) operations and 'local corruption' seemed to play a less important role (15.8 percent). However, established 'access to smuggling routes' for other types of crime (100.0 percent) is being used to 'infiltrate' (92.1 percent) the illegal trade in natural resources. Illustrations of this form of crime convergence include Thai and Indonesian organized crime groups involved in human trafficking transferring migrants for illegal fishing operations in Asia (Case nos 50, 63, 73), or Colombian and Peruvian *bandas criminales* forcing locals to work in the illegal gold mining industry as miners or prostitutes (Case nos 69, 85). In contrast to the first cluster, about one-fifth of these cases use legitimate companies to 'camouflage' (18.4 percent) their illegal activities. The main types in this cluster are 'wildlife & drugs', 'wildlife & humans', 'fish & humans', 'fish & weapons', 'timber & humans', and 'minerals & humans', as well as combinations within the 'unclassified' category.

Cluster 3: Green Camouflaged Crime

Cluster 3 is named the *Green Camouflaged Crime* cluster and is the smallest cluster, with 26 cases. This cluster is characterized by small and medium-sized (30.8 percent and 57.7 percent respectively) organized crime groups that are predominantly involved in drug trafficking. The cases in this cluster almost always scored zeroes on the variables related to diversification into the illegal trade in natural resources. Surprisingly, in contrast to the *Green Organized Crime* and *Green Opportunistic Crime* clusters, these low-level diversifiers, illustrated by their small crime range (76.9 percent), usually 'camouflage' (92.3 percent) their illegal businesses with a legitimate company – for instance, Asian timber companies that are being used by Burmese organized crime groups to smuggle illegal heroin within timber logs (Case nos 30, 31, 32) and South American drug cartels that use fishing vessels to shield their cocaine trade (Case nos 10, 78, 79, 80, 92). Interestingly, despite the minor level of convergence, traditional organized crime groups are established in this cluster; Colombian and Mexican drug cartels, Italian mafia and Asian organized crime groups among others were identified in the crime cases of the third cluster. Furthermore, it can be argued that these traditional crime organizations have established minor relationships with environmental crime networks but adopt their operational services and access to smuggling routes (80.8 percent) to commit environmental crimes and launder drug money. For example, gold companies are being used by members of the Gulf Clan and the 'Ndrangheta to launder profits from the trade in cocaine (Case nos 4, 87, 90). The main types in this cluster are 'fish & drugs' and 'timber & drugs'.

Discussion and conclusion

In various ways, criminologists, policymakers, and law-enforcers have grappled with organized environmental crime in isolation from other serious crimes. However, the link to other criminal activities is of particular interest; a recent study highlights that 84 percent of the responding countries report convergence between environmental crime

and other serious crimes (Interpol, 2016: 22). For example, the diversification of organized crime in times of global scarcity is illustrated by the smuggling of ivory and minerals by hybrid criminal organizations involved in the weapons and ammunition trade for militias (Usanov et al., 2013; Vira and Ewing, 2014; UNEP, 2015), as well as drug cartels that combine shipments of timber and drugs or exchange endangered species for cocaine (De Greef and Raemaekers, 2014; Elliott, 2009; Felbab-Brown, 2015; RENCTAS, 2001; South and Wyatt, 2011). The increase in environmental crime each year, combined with its disastrous consequences for the world, shows the importance of investigating the diversification of organized crime into the illegal trade in natural resources.[21]

In this article, we analysed 106 international environmental crime cases with links to other serious crimes, such as the trade in drugs, humans, and weapons. Cluster analysis was used to summarize these data into subtypes to gain insights into the underlying data structure. The two-step cluster algorithm found a cluster solution with three distinct clusters of subtypes of criminal groups that had diversified into the illegal trade in natural resources in differing ways. Within the three clusters, the criminal groups have distinctive shapes, features, and characteristics, varying from well-organized groups that have started to dominate specific segments of environmental crime to flexible and fluid opportunistic networks that explore alternative markets for profits.

The three clusters can be related to specific stages within the environmental crime continuum, albeit with nuances. First, the *Green Organized Crime* cluster, with a high degree of diversification, relates to the stages of Transformation (Category 4) and Domination (Category 5). This cluster reflects how criminal groups transform their features to adapt to changing circumstances, diversify into environmental crimes, or even start to dominate a specific area or trade line in the underworld. Second, the *Green Opportunistic Crime* cluster mainly relates to the stages of Mutualism (Category 2) and Convergence (Category 3), comprising dynamic criminal groups with a reasonable degree of diversification reflected by multiple trade lines. In other words, these groups do not shift to environmental crime but use their expert knowledge and are opportunistically involved in the illegal trade in natural resources. Third, the *Green Camouflaged Crime* cluster can be linked to the early stages of Alliances (Category 1) and Mutualism (Category 2), where criminal groups are low-level diversifiers. Such groups use their access to smuggling routes to transfer illegal goods or use legitimate companies to camouflage their traditional criminal activities in the upperworld. Even though the various components of the environmental crime continuum were identified in this study, the clusters interact and overlap. For instance, some cases included in the Green Organized Crime cluster could also be considered theoretically to be part of the Green Opportunistic Crime cluster, and concepts such as barter trade were predominantly found in the Green Organized Crime cluster, although expected in the stages of Mutualism (Category 2) and Convergence (Category 3).

Therefore, the descriptions of the three clusters presented above must be seen as ideal types, which help to understand how the data relate to the theoretical framework. Although a reasonable structure has been found in the data, it is important to note that the results of clustering procedures can change by adding or omitting cases and variables. The results should be seen as products of the summarization of this particular

dataset. This implies that the way the data are collected and the number of cases that are analysed may change the relationships between variables and thus the cluster solution. Furthermore, unmeasured variables, for example social relations between crime groups, could influence the relationship between variables and result in different cluster solutions.

This article aimed to improve understanding of the diversification of organized crime by looking at the convergence of environmental crime and other serious crimes. Previous criminological research frequently analysed forms of illicit trade as separate crimes, but we argue that transnational environmental crime is not exclusively a standalone phenomenon. This raises a number of complexities and challenges in all phases of enforcement and policymaking, from detection and disruption, to the dismantling of organized crime groups; for example, many law-enforcers specialize in one specific crime, which is problematic when reacting to the diversification of organized crime (Interpol, 2015). Thus, the results provide insights into how transnational crime groups seem to evolve in myriad ways, but they may also help law-enforcers with different mandates to better align their resources to tackle crime problems simultaneously. In order to empirically reveal how traditional, territorial-based criminal groups have developed endogenously, how they cooperate with exogenic environmental crime groups, or how they have been (partially) replaced by infiltrators, qualitative research is highly recommended in environmental crime nexus hotspots such as the Darién Gap, the Golden Triangle, and the Congo Basin (see Van Uhm, 2019, 2020b).

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ORCID iD

Daan P. van Uhm https://orcid.org/0000-0003-3696-5982

Notes

1. No formal definition of organized crime exists and many concepts of organized crime have been discussed within criminology; it remains an 'unclear and ambiguous concept' (for example, Fijnaut et al., 1998; Levi and Maguire, 2004; Paoli, 2002; Siegel, 2008: 86). In this article, the rather broad United Nations definition of organized crime will be used: 'a structured group of three or more persons, existing for a period of time and acting in concert with the aim of committing one or more serious crimes or offences established in accordance with this Convention, in order to obtain, directly or indirectly, a financial or other material benefit' (UNODC, 2004: 5).
2. Traditionally, organized crime groups focus on international smuggling activities, such as drug trafficking, arms trafficking, and human trafficking (Gambetta, 1993; Siegel et al., 2003; Thoumi, 1995; Varese, 2011; Zhang and Chin, 2002), but, more recently, trafficking in wildlife, timber, and other natural resources has been linked to organized crime activities (Boekhout van Solinge, 2014; Van Uhm, 2020a; Wyatt, 2013).
3. Although in some parts of the world increased border security has become an important topic

in the last few years, in the context of trade many borders are becoming more porous or virtual, which provides new opportunities for criminal entrepreneurs (Galeotti, 2014; Siegel et al., 2003).

4. Multifaceted crimes are more complex logistically than single crime activities (Shelley, 2017).

5. In this modus operandi one illegal commodity may be hidden within or by a different but legal commodity. There is a difference between camouflage methods: on the one hand, 'lawful, but awful' commodities such as snakes being used to cover the illegal trade; on the other hand, undertakings that are accepted as 'business-as-usual' (Passas, 2005: 781; South and Wyatt, 2011).

6. Crime-related camouflage methods allow criminals to hide illegal activities in plain sight (Felson, 2006: 283).

7. Because there is no available international database with a complete overview of existing international environmental crime cases, it is unclear what the proportion is of the selected cases in relation to all cases of environmental crime with links to other serious crimes. Moreover, the number of different types of environmental crime and organized crime is not representative because it reflects detection and prosecution efforts too (Coleman and Moynihan, 1996).

8. It is difficult to determine with certainty whether the origin and destination countries are the actual origin and destination countries in the cases (see also Petrossian et al., 2016; Van Uhm, 2016b). For instance, it may be that timber is recorded in a case as Malaysian timber but in reality it consists of Indonesian timber, or illegal tortoises being seized in the Netherlands that may be destined for Germany instead. In this study, we coded the exporting country of contraband as the origin country and the country where the seizure took place as the destination country.

9. CIA World Factbook, URL (accessed 21 January 2020): https://www.cia.gov/library/publications/resources/the-world-factbook/index.html.

10. Conservation International identified 17 megadiverse countries in 1998. The term 'megadiverse country' refers to nations that contain the majority of the Earth's species and high numbers of endemic species; see also URL (accessed 21 January 2020): https://www.conservation.org.

11. This indicates that countries with rich biodiversity density are subject to the 'resource curse'; countries with an abundance of natural treasures (minerals, timber, wildlife), paradoxically, tend to have reduced levels of development and higher levels of corruption (Kolstad and Søreide, 2009) and crime (Boekhout van Solinge, 2014; South and Brisman, 2013). According to Brisman and South (2013: 57), '[t]his has manifested itself as the damaging and divisive exploitation of environmental wealth in forms such as illegal trades in diamonds, timber, and wildlife that, in turn, have generated funds that have supported and perpetuated internal conflicts, corruption, and the externalising of economic surplus.'

12. A biodiversity hotspot is a biogeographic region with exceptional concentrations of endemic species that are undergoing exceptional loss of habitat. Although the Congo Basin rainforest as a whole is not a biodiversity hotspot, the western and eastern edges of it are (the Guinean Forests of West Africa biodiversity hotspot and the Eastern Afromontane biodiversity hotspot) (Myers et al., 2000).

13. For instance, since the increasing restrictions on opium trade in the Golden Triangle, there is now more emphasis on illegal timber and animal products (Categories 4, 5) (Kahrl et al., 2004; Van Uhm, 2016a), minerals and ivory from the Congo Basin are regularly smuggled by criminal organizations involved in the weapons and ammunition trade for militias (categories 1, 2) (Agger and Hutson, 2013; UNEP, 2015), and drug cartels in Colombia smuggle mixed shipments of timber and drugs or exchange drugs for endangered species, resulting in cashless transfers (barter) (Categories 2, 3) (ECOSOC, 2002; Sollund and Maher, 2015).

14. Some items could not be used owing to missing information from the lawsuits.
15. The category 'serious crimes' includes both environmental crimes and other serious crimes (see Article 2b of the United Nations Convention against Transnational Organized Crime).
16. In this study, the variable 'minerals' includes conflict minerals such as tantalum, tin, tungsten, and gold, which are the derivatives of the minerals cassiterite, columbite-tantalite, and wolframite, respectively.
17. The two-step algorithm can be sensitive to the order of cases (Sarstedt and Mooi, 2014). Therefore, cases were ordered randomly to evaluate the stability of the cluster solution.
18. This refers to the ratio of sizes: largest to smallest cluster.
19. This agglomerative hierarchical algorithm shows that 82.1 percent of the cases are included in the same clusters as with the two-step algorithm, when we assume that the three clusters are substantially the same for both algorithms.
20. Even though the two-step cluster analysis resulted in three subtypes of criminal networks that appeared in the nexus of environmental crime and other serious crimes, it may well be that other subtypes exist (for example, with a higher sample size).
21. Environmental crime is growing at a rate of at least 5–7 percent annually. This estimate is based on registered trade statistics, seizures, and reported incidents. For example, the reported incidents of illegal wildlife increased substantially in the last decade and e-waste has been reported to have increased from an estimated 41.8 million metric tonnes in 2014 to 50.0 million already by 2018. The rise in environmental crime is concerning because it is 2–3 times the rate of growth of the global economy (Nellemann et al., 2016: 7–8).

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