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Policy Communication and the Influence of Agricultural Communities on Karst Landscapes: A Case Study In Phong Nha-Kẻ Bàng National Park, Vietnam

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POLICY COMMUNICATION AND THE INFLUENCE OF AGRICULTURAL COMMUNITIES ON KARST LANDSCAPES: A CASE STUDY IN PHONG NHA-KẺ BÀNG NATIONAL PARK, VIETNAM

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DEDICATIONS

This work is dedicated to James Tyler Graham, my greatest champion.

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POLICY COMMUNICATION AND THE INFLUENCE OF AGRICULTURAL COMMUNITIES ON KARST LANDSCAPES: A CASE STUDY IN PHONG NHA-KẺ BÀNG NATIONAL PARK, VIETNAM

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Karst landscapes are vulnerable to human influence, especially agricultural practices. The interconnectedness between surface activities and subsurface environments make karst landscapes particularly susceptible to soil erosion and water contamination. The likelihood of these two phenomena happening increases when agricultural intensification, irrigation, or fertilizer application occurs. This situation arises frequently in Vietnam, where 18% of the country is karst terrain and 60% of the population depends on agriculture for their livelihoods (Farming First 2009). In order to mitigate the negative consequences of agriculture on karst landscapes, effective implementation of policy to regulate human activities and increased communication of these policies to appropriate communities is needed. This study occurred in Phong Nha-Kẻ Bàng National Park, Vietnam, a UNESCO World Heritage site dominated by karst landscapes, extensive agricultural communities, and minimal regulation efforts specific to karst terrains. Interviews, observation, and GPS analysis were used to analyze the effectiveness of policy communication and karst protection in PN-KB. The research revealed that karst protection policy in the region is minimally communicated and, when communicated, often delivered in an ineffective manner to the wrong individuals. Despite the known harm agriculture causes to karst landscapes, intensification, irrigation, and the use of fertilizers still occurs frequently and is often supported by

government officials in PN-KB. Policy and karst landscape information is concentrated among park officials and rarely presented in an informal setting, leaving those in most frequent contact with the karst landscape—the farmers—without any information about the vulnerability of karst terrain to agricultural activities and the subsequent consequences to human health. Through analyzing the interactions between farmers and management officials in Phong Nha-Kẻ Bàng National Park, general conclusions on communicating policies to protect karst terrain in agricultural regions can be drawn. The communication of karst science and the implementation of policy to protect karst landscapes must be presented both formally to governing officials and local representatives, as well as through informal networks to general citizens. Through these means of communication, protection for karst landscapes and their inherent natural resources can successfully be implemented.

CHAPTER 1: INTRODUCTION

A growing population and its increasing demand for food has led to the burgeoning need for both commercial and subsistence agriculture throughout the world. Farmers in developing countries earn a living and feed their families through agriculture; however, with greater need comes unideal agricultural circumstances. Arable land is becoming over-intensified and agriculture is being moved to areas less suitable for cultivation (World Bank 2008). In some regions, the stress of subsistence and commercial agriculture directly conflicts with a country's natural geological terrain.

Agricultural practices often have a negative impact on groundwater and cave ecosystems where large agrarian communities live on sensitive karst landscapes (Ford and Williams 2007; Fleury 2009). Agricultural communities that utilize fertilizers or pesticides, and that focus on high yields or monocultures, are at increased risk for eroded soils and groundwater contamination (Fleury 2009; Jiang et al. 2009), which, in karst areas, also threatens the integrity and health of karst features such as sinkholes and caves, as well as karst-specific flora and fauna. In some cases, policies and practices exist to help protect the karst environment and mitigate potential agricultural impacts; however, protection guidelines are only effective if clearly communicated to, and understood and practiced by, those living in vulnerable communities, particularly in developing countries where resources to achieve this may be limited. Often, a disconnect exists between the intention of protecting a karst environment and ensuring that people are aware of the need to protect it as a means of preserving their livelihood.

Areas of vulnerable karst topography are increasingly regulated through legislation and land management policies. In areas with implemented karst policies, the

general population often has minimal understanding of the policy intent, and there lacks knowledge about what karst terrains are and why they are vulnerable to human impact. These misunderstandings result in sustained agricultural malpractice to the landscapes (LaMoreaux et al. 1997). The purpose of this study was to investigate how informal communication can be used as a technique for promoting and/or enhancing the protection of karst terrains where agriculture practices are prevalent.

Currently, there is limited research to understand the intersections of protected areas, agriculture, and the informal communication of karst protection policies. The karst area of Phong Nha-Kẻ Bàng National Park (PN-KB) in Vietnam is managed through government policy and is home to a large, rural agrarian population. Additionally, since the creation of PN-KB thirty years ago, research suggests that it has not successfully protected its karst landscape nor subsurface features (North et al. 2016), making it a perfect case study site for better understanding how karst policies can be more effectively and efficiently communicated to residents living on vulnerable karst landscapes. The management of PN-KB lacks with regard to communication to local populations, which threatens successful implementation of policy to protect the region's karst landscape (Hübner et al. 2014). Specifically, PN-KB has a management board, but lacks adequate funding and extensive educational and human resource departments; rangers that patrol PN-KB are trained in specific areas, but lack education in agriculture and karst landscapes (North et al. 2016). Maladapted communication methods utilized by park rangers and officials hinder the enforcement of park policy and the protection of its karst areas. This is exacerbated by a perceived park mission of protecting the forest and animals, with minimal understanding of how the biodiversity of PN-KB is closely

linked to its karst terrain. The vast majority of information on karst landscapes that is provided to park officials comes from outside scientific researchers and is minimally understood by park staff. Additionally, a mission to protect the karst landscape is neither understood, nor supported by the provincial government, resulting in little to no resources dedicated towards karst landscape protection efforts.

Often, formal communication methods utilized by park representatives favor rangers, local government officials, and upper-class Heads of Villages (Hoang et al. 2006). Those with the most information on karst landscapes, the park officials, are rarely in communication with park residents; therefore, the most important information on how to protect the karst landscape of PN-KB never reaches those in most frequent contact with the land, which is the farmers. Conversely, informal communication methods used within the farming community disperses important information thoroughly to all social classes, but a general lack of information on karst terrains means that the potential for positive influence of the information to reduce degradation to the landscape is minimized (Hoang et al. 2006; Khatam et al. 2013).

1.1 Research Questions

By studying informal communication networks within the PN-KB agricultural communities, the researcher was able to explore how the communities are affected by the presence of a karst terrain. These networks were assessed for their ability to spread karst land management information and policy. The main research question for this research was, "**How can land managers in karst regions where agricultural practices occur use informal communication techniques to effectively communicate and**

enforce karst protection policies to farmers living within those areas?" Sub-questions for this research included:

- How can informal communication techniques be used by Phong Nha-Kẻ Bàng National Park officials to effectively communicate and enforce karst policies to farming families within the Park?
    - What content communicated by PN-KB officials most successfully informs PN-KB residents of the need for karst protection?
    - Which informal communication techniques most successfully promote karst protection?

This study explored the ways in which informal communication can be used to emphasize understanding of strategies to protect karst landscapes and, therefore, successfully apply karst protection policies. The PN-KB Management Board can use the findings of this study to implement an effective informal communication strategy for communicating to farmers about the sensitivities of karst landscapes to degradation and the policies implemented to address these sensitivities. Although this study focuses on Vietnam as a case study site, shortcomings in policy implementation, due to ineffective education and communication, is a common occurrence in many karst regions where agriculture is prevalent. Through answering the aforementioned research questions, this study aimed to better understand how agricultural communities receive information about and implement federally regulated karst policies.

CHAPTER 2: LITERATURE REVIEW

Karst terrains, agricultural practices, and land management are closely intertwined. Agriculture is an economic staple for over one third of the world's population (World Bank 2008; Schindler et al. 2015). Additionally, karst landscapes cover between 20 and 25% of the world's surface and karst aquifers provide 25% of the world's freshwater resources (Ford and Williams 2007). These two systems interact frequently and each influences the other. Ford and Williams (2007) estimated that agriculture causes some of the greatest degradation to karst hydrology and natural geomorphology. Moreover, the widespread nature of karst landscapes and agricultural practices means that priority placed on one can have unforeseen, negative consequences on the other. These systems and their influences are especially pronounced in southeast Asia, where extensive karst terrain and large-scale subsistence farming are dominant (Urich et al. 2001). In southeast Asia, there is extensive conflict between karst land protection and maintenance of agricultural livelihoods. Through the implementation of protected areas, mediation between the human and karst systems can be reached. This must occur through proper land management policy implementation and enforcement at local levels. By studying communication patterns and rural social networks, human livelihoods can be managed and karst lands can be protected.

2.1 Karst Landscapes

Karst areas are typified by landforms and hydrology that result from the dissolution of carbonate rock (White 1988; Ford and Williams 2007). These terrains are home to karst features such as caves, sinkholes (dolines), underground rivers, freshwater aquifers, barren plateaus, and rocky cliffs (White 1988). Deforestation, urbanization, and

agriculture cause significant land degradation, soil erosion, and water quality issues in these regions; these occur because of the interconnected nature of surface activities and subsurface processes (Ford and Williams 2007; Coxon 2011).

Karst formation occurs when rock structure, flowing water, and time align to form ideal conditions for dissolution. Water combines with carbon dioxide to create carbonic acid, which then permeates through carbonate rocks, such as limestone, dolostone, or gypsum (White 1988; van Beynen 2011). The weak carbonic acid enters from the surface and moves through the pores in carbonate rock, dissolving the rock to create voids of varying sizes. This process transfers surface fluids to the subsurface to form caves, which are home to underground rivers and freshwater aquifers (White 1988).

Due to the nature of its hydrology, karst landscape processes are largely influenced by human activity (Ford and Williams 2007). Sinkholes and surface fissures act as direct passages to the subsurface; water can also travel through soil to reach the subsurface rock (White 1988; Palmer 2007). Because of the high porosity and permeability of carbonate rock, water transport between the surface and subsurface occurs quickly and with minimal filtration. This process is prone to the leaching of surface pollutants, which can travel through the rock to eventually contaminate water flowing underground (Figure 2.1) (Morkunas et al. 2005; Jiang et al. 2009; Ciglič et al. 2012). These contaminants can eventually resurface through springs, polluting surface waters (Drew 1983; Morkunas et al. 2005). Sewage, fertilizers, pesticides, and farm waste can wash into nearby sinkholes or fissures and degrade subsurface water quality (Jiang et al. 2009; van Beynen 2011; Ciglič et al. 2012).

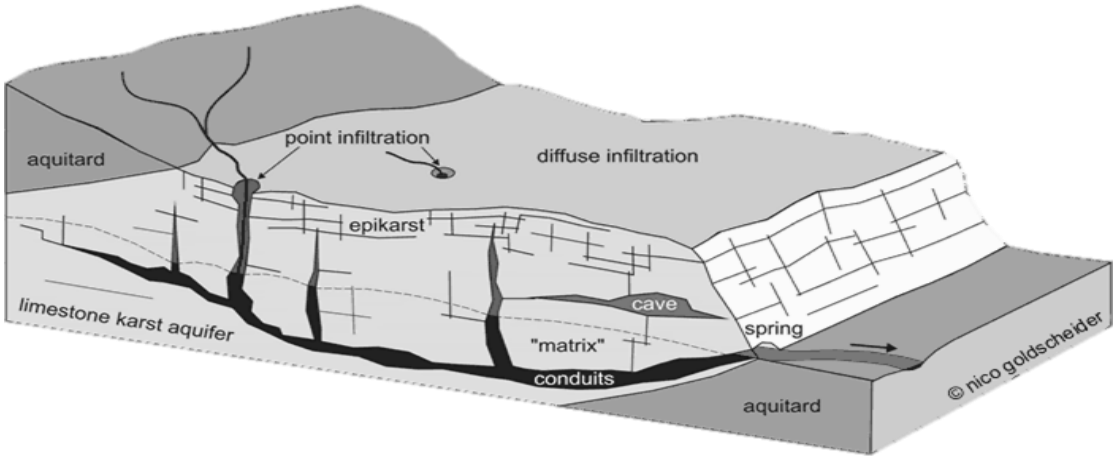


Figure 2.1: Hydrology affecting karst aquifers (Sourced from Goldscheider and Drew 2007, 3).

In addition to their complex hydrology, karst landscapes have low soil formation rates and are vulnerable to soil erosion (Drew 1983; Chen and Bi 2011). Frequent or intense soil erosion can cause soil damage that is difficult, if not impossible, to remedy. Additionally, surface contaminants in the soil also leach into the aquifer and cause contamination (Drew 1983; Morkunas et al. 2005; Jiang et al. 2009; Chen and Bi 2011).

2.1.1 Karst and Agriculture

The diverse negative influences of agriculture to karst features include, but are not limited to, deforestation, chemical inputs, and water usage (Coxon 2011). In karst regions where agricultural practices occur, trees are often cleared to allow for cultivation or livestock grazing. Removing trees and roots results in a decrease in biodiversity, an increase in soil erosion, and significant changes in local hydrology (Drew 1983; Jiang et al. 2009; Coxon 2011; Ciglič 2012). In deforested areas, water moving from the surface to underground conduits and caves is more likely to transport sediments and surface contaminants such as applied fertilizers and pesticides. The heightened amount of

suspended sediments and chemicals in the water, in combination with diminished filtration capacities of karst soils and bedrock, results in highly contaminated subsurface water (Coxon 2011; Ciglič 2012). Contaminated water can flow through extensive underground karst networks, threatening the system's geologic and biologic integrity. Additionally, changes in surface landscapes, such as deforestation or agricultural intensification, can alter water infiltration and runoff; therefore, large amounts of water can be introduced or taken away from surface and subsurface karst features, influencing their natural formation rates (Coxon 2011). Changes in water influx into subsurface cave environments can also impact cave species, which often depend on stable cave environments for survival (Jiang et al. 2009). Despite the negative influences of agriculture on karst landscapes, the necessity to make a living can push farmers to increase grazing or crop production at the expense of the health of the landscape (World Bank 2008; Leisher et al. 2011). Fertilizers and imbalanced soil nutrients in the water, which is used for irrigation, compromise crop success (Chen and Bi 2011). Overall, rural farmers living on karst terrains are stuck in a cycle of intensification, inferior crops, and land degradation (Coxon 2011; Leisher et al. 2011).

Though Coxon (2011) argues that farming on karst landscapes threatens geographic sustainability and the biodiversity needed for successful crop cultivation, he fails to recognize the worldwide reliance on agriculture. Both commercial and subsistence farming are vital for economic and nutritional support of a growing global population. This, in addition to widespread karst land cover, means that, in some areas, a relationship between karst and agriculture is necessary (Urich 1989, 1993), but studies on how to facilitate this relationship are lacking. In karst areas where agriculture is

prevalent, there is increased need for effective karst-related communication, education, and policy (Ford and Williams 2007).

2.2 Policy

2.2.1 Agricultural Land Delegation

The world's rural population is largely reliant on agriculture (Machethe 2004; World Bank 2008). For some populations, subsistence farming provides daily nourishment; for others, commercial agriculture is a source of employment. Land is not just a physical space, but also the definition of cultures, families, and policies (Rigg 2005). Around the world, land is owned and divided in different ways. In rural economies, land delegation is broadly allocated into two main categories of private ownership or tenancy (Hoeks et al. 2014).

Some rural families own their land, which is often the case with smallholder subsistence farming (Rigg 2005). In these areas, land tenure is central to an individual's economic status, social roles, and placement among village elite (Marsh and MacAulay 2006; Hoang et al. 2006; Kerkvliet 2006; Demíryüek 2010). Farming households are often comprised of many generations. The conveyance of information and delegation of physical land is largely determined by this lineage. Families with a long lineage or wealth may have better access to high-quality land and resources. Poor families, or those with short land tenure, have limited access to high quality areas and are left with unfavorable land and fewer resources (Hoang et al. 2006). This social structure also influences communication patterns and networks (Hoang et al. 2006; Wood et al. 2014), but studies of land tenure and social structure do not often discriminate between landscape types.

The second type of land delegation is based on tenancy. Large plots of land owned by the government, or another wealthy being, are rented to small-scale farmers (Marsh and MacAulay 2006; Kerkvliet 2006; World Bank 2008); these may be subsistence farms, commercial farms, or both. Rented land often exists in one area, but is made up of smaller plots of varying quality. For example, a family will pay for three plots of land, but will receive one good plot, one mediocre plot, and one plot of unfavorable land (Kerkvliet 2006). In these areas, families can trade their land, but because they do not have ownership, they cannot sell it. Similar to the private ownership system, generations of tenant farming families often live and work together. Land tenure is also important in a community's social structure, dictating social status, access to technology, and quality of resources (Hoang et al. 2006; Hoeks et al. 2014; Wood et al. 2014).

While differences exist between land ownership and land tenancy, both methods of land delegation emphasize the role of family. Each generation farms the land, expands its practices, and then bestows the physical and theoretical developments upon the next generation (Hoeks et al. 2014). Many families remain in this cyclical process in the same area. Conversely, some families may uproot their land tenure to relocate to a new area or region. This move can be driven by many things, but it is most often caused by desire to find better land and generate more income (Hoang et al. 2006; World Bank 2008). If families do choose to relocate, there is typically a drop in social class (Hoang et al. 2006).

Farms operated by households are more likely to provide income and promote safe land-use practices (Hoang et al. 2006; Kerkvliet 2006). No matter ownership or tenancy, when a family farms as a unit, there is a greater quantity and dispersion of agricultural knowledge. This can vary from familiarity of soils to natural irrigation

practices and to which crops thrive on certain landscapes. Generations of trial and error produce a deeper understanding of these techniques. Additionally, accountability for land maintenance and future land productivity result in greater attention to vulnerable land and increased use of safe farming practices (Hoang et al. 2006). Families are in essence social networks, as well as networks of information and accountability.

Agricultural policy and land delegation are different throughout the world. These systems are particularly important on karst landscapes, because of the vulnerable and sensitive relationship between agriculture and the land (Urich 1989). Dispersion of land, programs to protect agriculture, and policies to protect karst landscapes are all vital for sustainable land development, but often receive little study or attention during management plan development.

2.2.2 Land Management and Protected Areas

Just as there are policies to ensure individual access to land, there are also policies to protect vulnerable karst landscapes. As previously explained, karst terrain is extremely sensitive to degradation from multiple types of human activity, such as agriculture. Because of this, governments around the world have implemented various policies that vary in size and scope (Naughton-Treves et al. 2005). Substantial human influence on karst landscapes can take a long time to reverse, but the act of simply moderating this influence can aid in restoration (Ford and Williams 2007; Fleury 2009). The most proactive and intense protection policy involves nationally sanctioned protected areas and buffer zones (Lynagh and Urich 2002; Naughton-Trees et al. 2005; Fleury 2009). Up to six different types of protected areas exist: strict nature reserves, wilderness areas, natural parks, natural monuments or natural features, habitat management area and species

management area, and protected landscapes or seascapes (Naughton-Treves et al. 2005). For this study, only protected areas designated as national parks are discussed.

Protected areas are defined as geographic areas created to neutralize human impact and promote natural geologic processes. These areas are often home to vulnerable landscapes or threatened ecosystems (Naughton-Treves et al. 2005). Some protected areas completely outlaw human contact, while others may be used for nature-based tourism. National governments are most often the creators of protected areas and their management is delegated to a smaller authority, frequently land managers or national park staff (Naughton-Treves et al. 2005). The core zone of many protected areas are surrounded by a buffer zone (Figure 2.2). This region forms an outer boundary to the core zone to create physical distance between vulnerable areas and human activity. While some buffer zones do not allow human occupation, many do in various forms. Designated for environmentally sustainable community use, humans in these areas may be allowed to practice regulated agriculture and other daily activities (Lynagh and Urich 2002). Buffer zones, like protected areas, are managed by federally delegated individuals (Naughton-Treves et al. 2005; Hübner et al. 2014).

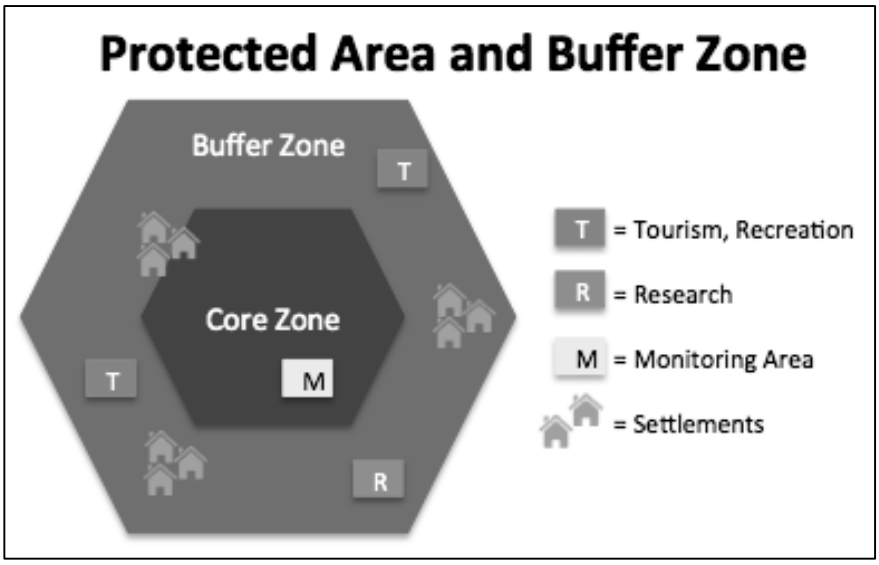


Figure 2.2: Protected area and buffer zone diagram (Modified from George Wright Society 2016).

The management of protected areas and buffer zones is historically controversial. National protected areas are often overseen by nationally appointed land managers. Buffer zones may be overseen by nationally appointed management teams or local community leaders within the zone (Lynagh and Urich 2002; Naughton-Treves et al. 2005); both systems possess several flaws. When nationally appointed land managers supervise locally populated buffer zones, little attention is paid to the livelihoods and wellbeing of that population (Urich et al. 2001). In a case study from the Philippines, Urich et al. (2001) reported that uneven power distribution in favor of federal employees often leads to miscommunication and conflict between national services and the local community. These conflicts create distrust of national managers by local populations. Urich et al. (2001) also described that distrust results in incomplete enforcement of protected areas and sustained degradation of vulnerable land. Conversely, when community leaders are appointed to buffer zone management, local populations keep their livelihoods at the expense of the vulnerable terrains (Urich et al. 2001; Lynagh and

Urich 2002; Naughton-Treves et al. 2005). By placing this control in the hands of local populations, the protected area managers will face less backlash and can more effectively implement protected zones (Urich et al. 2001; Lynagh and Urich 2002). The tradeoff, however, is sustained human presence and influence on the environmental health of the protected area. While there are likely instances of national and local leaders partnering for buffer zone management, there is little research on best practices or success rates of such partnerships.

Protected areas and buffer zones are successful in some aspects, while lacking in others. On one hand, the core areas effectively preserve natural processes (Naughton-Treves 2005); however, the social and environmental success of protected areas and buffer zones is widely debated. Land preservation is often at odds with local livelihoods (Urich et al. 2001; Lynagh and Urich 2002; Naughton-Treves et al. 2005; Ford and Williams 2007; Leisher et al. 2011). Social and cultural norms within communities, as well as the reliance on subsistence agriculture, can limit the management and protection of karst regions. Especially in areas with high population and increased need for food, intensive land use becomes a necessity and land management becomes more difficult; therefore, buffer zone communities with a rich sociocultural history on the land are difficult to regulate and karst land is left under protected (Ford and Williams 2007).

Upon the creation of a protected area, populations that are native to that land are either evicted or forced to sell their properties (Naughton-Treves et al. 2005); these populations may move away completely or settle in the buffer zone. A study by Naughton-Treves et al. (2005) revealed that successes in vulnerable land preservation are tempered by unintended consequences. For displaced populations, a decrease in land or

employment leads to increased illegal exploitation of resources in the protected area. Additionally, when resettled in buffer zones, local populations are still able to practice agriculture; yet, intense cultivation or the use of fertilizers and pesticides in close proximity to the protected area still has an adverse effect on the land (Lynagh and Urich 2002; Naughton-Treves et al. 2005). The social and environmental consequences from inconsistent buffer zone management also undermine the overall success of protecting vulnerable landscapes (Ford and Williams 2007).

The protected area model is increasingly used to protect karst lands (Lynagh and Urich 2002). Because of distinctive karst geomorphology and hydrology, humans can cause landscape degradation through direct contact or even distant proximity to the land. Water quality issues prevalent on karst landscapes can be shaped by human and agricultural waste from miles away; therefore, the implementation of protected areas is vital to karst protection. More importantly, the buffer zones must maintain distance between human activity and karst terrains in order to decrease further degradation and studies are lacking on the best practice through which to achieve this balance.

2.3 Agriculture and Karst in Southeast Asia

2.3.1 Karst of Southeast Asia

Southeast Asia is a region of 600 million people spread across the Asian mainland and islands in the south Pacific. The population of southeast Asia has increased by 48% in the past thirty years and continues to grow (Jones 2013). Karst terrains cover 400,000 square kilometers in southeast Asia, or approximately 11.4% of the region. A rapidly growing population results in human encroachment and occupation of vulnerable karst lands. The landscapes are threatened by increasing human activity and agricultural

production, both of which result in a decrease in water quality and an increase in karst land degradation (Lynagh and Urich 2002; Naughton-Treves et al. 2005).

2.3.2 Southeast Asian Agriculture

Between 1980 and 2010, the population of southeast Asia increased from roughly 360 million to nearly 600 million (Jones 2013). While this population boom caused the movement of many people into the cities, over half of the population still resides in rural villages (Jones 2013). For the rural population, agriculture is still the main source of income and employment. In 2013, economic reliance on agriculture in the region varied from 20% in Malaysia, to upwards of 60% in Laos and Vietnam (Global Agriculture 2013). Most farming families rely on subsistence agriculture and small land plots (Figure 2.3) (Marsh and MacAulay 2006; World Bank 2008).

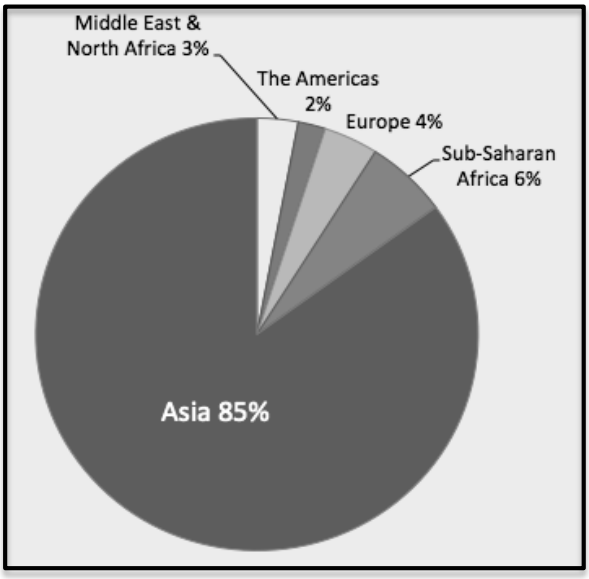


Figure 2.3: Global Distribution of farms less than one hectare. (Modified from Lowder et al. 2014 as cited in Global Agriculture 2013).

While many crops are grown in southeast Asia, the most historically common and widely produced crop is rice (World Bank 2008). Wet rice cultivation is broadly used on the hills of karst landscapes; however, rural populations in karst areas often lack agricultural technology and instead adapt cultivation methods to the harsh landscape (Urich 1989, 1992). Farmers in southeast Asia commonly believe that karst hydrology offers natural drainage and irrigation opportunities for rice paddy fields (Urich 1989); however, there are concerns about the sustainability of rice paddy cultivation, because of its reliance on karst groundwater, which is at a high risk for contamination. These concerns often result in disagreements between tenured farmers and government officials (Urich 1989, 1993; Urich et al. 2002). Overall, the social, economic, and cultural reliance on agriculture and vulnerable terrain of southeast Asia often pits human livelihood against environmental sustainability (Ford and Williams 2007). This conflict is especially evident in Vietnam, where there are frequent intersections of karst landscapes and agriculture that result in conflicts between farmers and policymakers.

2.4 Agricultural Land and Karst Management in Vietnam

2.4.1 Agriculture of Vietnam

Like other countries in southeast Asia, Vietnam has a long agricultural history; 80% of the population lives in rural areas and about 60% of this population is employed in the agricultural sector (Tuyet 2001; March and Macaulay 2006; Farming First 2009). Wet rice cultivation is the dominant agricultural practice in the region and yields are exported at a rate of 3.6 million tons per year (Ut and Kajisa 2006). While rice is a largely commercial crop, it is produced on small farms averaging 1.2 hectares in size (Marsh and MacAulay 2006). Over half the Vietnamese population works in agriculture,

but the country's revenues from the sector are steadily declining; currently, agriculture averages between five and ten percent of the country's gross domestic product (Ut and Kajisa 2006). Decreasing economic reliance on agriculture, but maintained employment in the sector reveals that farms are increasingly used for subsistence purposes.

2.4.2 Vietnamese Land Tenancy

Land delegation in Vietnam has varied in the past century. Vietnam was once a French colony and agricultural land was delegated in favor of the wealthy colonizers. After liberation in 1954, the communist Viet Minh redistributed the nation's agricultural land equally among farmers. In 1975, after the Vietnam War, agriculture policy shifted to land collectivization and communal farming. Farmers were to work on government-owned land in return for food and a modest living. This system was flawed and farmers began to take shortcuts to agricultural production. Families pooled their government-owned land and secretly used it to produce personal crops. As a result, agricultural production fell and tension rose between farmers and their government (Kerkvliet 2006; Marsh and MacAulay 2006).

With the *doi moi* land reforms in 1986, the Vietnamese government recognized households as the basic unit of agricultural production. Land is the people's property, but the Vietnamese government is both the land manager and delegator (Marsh and MacAulay 2006). Households are allowed to use land for whatever use they see fit, including trade and transfer rights (MacAulay 2002; Marsh and MacAulay 2006). Due to this transition, small farms became the basis for countrywide commercial production of rice (Kerkvliet 2006). Currently, Vietnam remains on a tenancy-based farm system; rural areas of the country are home to agricultural communities that act as small

communication networks on agricultural technology and production (Hoang et al. 2006; Kerkvliet 2006; Marsh and MacAulay 2006).

2.4.3 Vietnam's Land Quality

In addition to land reform, the quality of agricultural karst land in Vietnam is also important. Two events largely influenced the quality of the region's karst landscape: the Vietnam War and the Green Revolution. The Vietnam War ushered in the use of toxic chemicals, such as Agent Orange, a defoliant used for strategic deforestation and crop destruction. Agent Orange also contained tetrachlorodibenzo para dioxin, a harmful chemical known to cause long-term human health effects (BBC News 1998). Resulting degradation included soil erosion, chemical runoff, and groundwater and soil contamination (Stellman et al. 2003). In the short-term, these chemicals negatively affected agricultural production; more long-term effects include disturbance of vulnerable karst terrain and landforms (Wickle and Le 2013). These negative consequences disproportionally hurt rural farmers who faced short- and long-term burdens caused by Agent Orange, including decreased yield, damaged land, soil contamination and loss, and water pollution (Stellman et al. 2003).

After the Vietnam War, the Green Revolution swept across Vietnam. The Revolution, which aimed to increase market competiveness and rice production in Vietnam, began in areas favorable for agriculture, but its success resulted in the movement's spread into less favorable areas (Urich 1989; Ut and Kajisa 2006; World Bank 2008). Methods to increase agricultural output included the extensive use of fertilizers, increased irrigation, and intensified cultivation. In ten years, the country increased its cultivated land by four million hectares, resulting in a two-ton increase in

rice production per hectare (Ut and Kajisa 2006). Since cultivation requires cleared land, the spread of agriculture to Vietnam's karst slopes and valleys resulted in forests being cut and lands overtaken by farms (Tuyet 2001).

The cumulative influence from the Vietnam War and Green Revolution resulted in a 20% loss in Vietnam's forest cover; Vietnam's karst regions saw increased soil erosion and water contamination (Tuyet 2001; World Bank 2008). These issues persist currently and further threaten agricultural livelihoods and karst land health (Wickle and Le 2013). Despite extensive past degradation, the Vietnamese population maintains a reliance on agriculture, which, in karst areas, places an undue strain on the landscape (Marsh and MacAulay 2006; Ut and Kajisa 2006). The current connection between farming livelihoods and land management in Vietnam is conflictual and reinforces the need for policy to sustain both human and land wellbeing.

2.4.4 Karst Management Policy in Vietnam

Vietnam is home to 60,000 square kilometers of karst terrain, which covers 18% of the country (Tuyet 2001). Policy to protect this vulnerable land is in its infancy. During the twentieth century, there was little regard for the health of Vietnam's karst region; however, in the latter half of the century, policies started to change to protect damaged or degraded land (Hübner et al. 2014). During this time, there was a worldwide rise in protected areas and buffer zones (Naughton-Treves et al. 2006). Following international models, Vietnam adopted similar legislation and 7.6% of the country is now designated as protected sites (Hübner et al. 2014). In 1962, President Ho Chi Minh designated the country's first national park and protected area, Cúc Phương; PN-KB is largely covered in karst towers (McElwee 2002). Within the past 66 years, an additional

19 protected areas have been dedicated in Vietnam (Vietnam National Parks 2012). Protected areas and national parks are designated by the national government, but these areas are legally managed by the provinces in which they are located (McElwee 2002). For example, the management of Phong Nha-Kẻ Bàng National Park (PN-KB) in Vietnam is designated and led by the Quảng Binh Provincial Government (Hübner et al. 2014). Protected areas throughout Vietnam are managed differently. Some are managed as nature reserves, while others are divided into core and buffer zones with varying levels of protection (Naughton-Treves et al. 2005). While minimal information exists on the extent to which humans can live and develop in Vietnam's protected areas and national parks, it is known that protected areas with core and buffer zones have strict rules outlawing human interference in core zones (McElwee 2002).

No current information exists on whether Vietnam has any national policies to protect its karst terrain; however, three of Vietnam's current protected areas are karst regions and one, PN-KB, is managed though the use of core and buffer zones (Vietnam National Parks 2012). While the resources of these three protected areas are regulated, they represent only a portion of the karst landscapes in Vietnam. Moreover, since karst landscapes can be influenced by a wide surface area extending beyond karst surface features, these protected areas are likely expressing minimal control over karst degradation (Coxon 2011). Thus, minimal national laws to protect karst landscapes leave both karst resources and populations that depend on them unregulated and unprotected.

A protected area with both a core and buffer zone, PN-KB is a karst-dominated park in central Vietnam. The current policy of PN-KB protects the Park's abundant flora and fauna but lacks specific protections for its karst resources. Currently, PN-KB is

divided into a core and buffer zone, with the majority of the human population residing and working in the buffer zone. PN-KB's core zone is highly protected from human degradation, but the buffer zone lacks similar regulation. Therefore, while Vietnam's adoption of national parks and protected areas extends to the karst terrain of PN-KB, actual regulation and protection of the karst resources is minimal. For future protection of PN-KB's karst resources, comprehensive application of park policy to protect the karst terrain in PN-KB is necessary. Certain factors must be considered in order to effectively apply karst protection policies, such as the identification and use of communication methods that correspond to the cultural and social structure of the communities in which the policies will be applied.

2.5 Communication

2.5.1 Informal Communication in Agricultural Communities

The successful implementation of policy relies on its effective communication to target populations. There are two main methods of communication in agricultural communities. First, an inward, formal flow of information occurs from political and technological bodies to local communes. Second, that information, once received by village leaders, is communicated informally among community members (Hoang et al. 2006; Demíryürek 2010; Khatam et al. 2013; Wood et al. 2014). Formal communication occurs through conferencing, structured demonstrations, or workshops. Regional political representatives select upper social class villagers to receive the information (Hoang et al. 2006; Demíryürek 2010). A villager's social class is dictated by certain parameters, including land tenure, social network size, and agricultural expertise. Upper class

villagers identify with long, generational land tenure, an extensive social network, and high agricultural expertise. Middle class villagers are also successful farmers and hold some generational connections to the land, but are marginally less established. Low class villagers, however, have limited farming success, short land tenure, and isolated social relations (Hoang et al. 2006). The upper class villagers are the most frequent recipients of formal technological and political information and then spread the information through informal social networks (Hoang et al. 2006; Demíryürek 2010; Khatam et al. 2013; Wood et al. 2014).

Social ranking also shapes informal communication networks. Informal communication between classes is grouped based on social networks. A communication network involves all informal communication that occurs between families and neighbors (Khatam et al. 2013; Wood et al. 2014). Communication networks are large and typically incorporate all social classes. Most informal information transfer occurs between the extensive social networks of upper and middle class citizens; low class citizens rely on smaller networks with fewer middle and upper class contacts. By the time new technological or political information makes its way through the upper two classes and then to lower class villagers, it is often incomplete or incorrect (Hoang et al. 2006).

Formal communication into rural agricultural communities has limited success. Methods adopted by formal communicators do not parallel the structure within which they are received. First, the culture and class of formal communicators differ from that of the message recipients. Culture and relationships play a cohesive role within agricultural communities (Rigg 2005). Communication to and from outside sources is sporadic and lacks cultural appeal; therefore, it less likely to have deep meaning to the villagers

(Hoang et al. 2006; Wood et al. 2014). Second, inward communication bias in favor of upper class community members isolates the flow of communication. Formal communicators funnel technological and political information to upper-class villagers who are falsely assumed to be the central component to rural social networks. The knowledge often remains in the middle and upper classes. Significant time and message distortion occur before the information reaches the lowest class. New information is socially biased and becomes misconstrued as it makes its way down the class structure. Formal communication, therefore, polarizes the classes, sets up lower class farmers for failure, and undermines the application of important political and technological advances (Hoang et al. 2006).

Studies by Hoang et al. (2006), Khatam et al. (2013), and Wood et al. (2014) reveal that informal communication networks are intergenerational and cultural, and are therefore, the most successful way to spread information in agricultural communities. The information is incited, spread, and controlled by the population itself. Informal communication of agricultural information is not only a social activity, but also a promotion of a villager's cultural and economic reliance on farming (Rigg 2005). Additionally, informal communication occurs within and between all classes; it is less centralized than formal communication and more conducive to the village setting of rural agricultural communities (Wood et al. 2014). Informal communication in rural, agricultural communities is not just a flow of information, but also a practice of livelihood and culture. Few studies exist that explore how communication of agricultural practices is influenced by karst landscapes and their complexity.

2.6 Conclusion

Rural communication in Vietnam is similar to the general trends explained previously. Hoang et al. (2006) studied the role of communication in local policy application in rural Vietnam and found deep divides between the formal communication of government figures and informal communication of agricultural social networks. The cultural differences between the two groups hinder communication significantly. Uneven inward flow of communication and message distortion during social network transference results in incomplete policy implementation. Despite these findings, Hoang et al. (2006) failed to emphasize the influence of communication techniques on the actual policy implementation. When essential communication is hindered, negative consequences of human activity can manifest in the physical environment in which the policy was meant to occur; therefore, due to misunderstandings of social structure by government and technological representatives, agricultural policy in Vietnam is poorly executed.

Overall, there is limited research on the intersections of protected areas, agriculture, and informal communication. Moreover, communication in Vietnamese agricultural communities is infrequently studied, particularly in karst areas. While karst protection and agricultural policy are mainstream in Vietnam, there are no studies on the ways that these influence rural communities. Furthermore, the extent to which these policies protect the country's vulnerable karst landscape of the country is understudied. These research gaps are specifically pertinent to the management of PN-KB in Vietnam. This karst area is both formed and managed through government policy; in addition, its buffer zones are home to a large rural agricultural population. Since the creation of PN-KB thirty years ago, research suggests that it has not successfully protected its karst

terrain (North et al. 2016). Additionally, the intersections of karst land management, agricultural policy, and informal communication within PN-KB are poorly understood. If studied, findings can provide insight into the mediation between karst land protection and local agricultural livelihoods.

CHAPTER 3: STUDY AREA

This study took place in Phong Nha-Kẻ Bàng National Park (PN-KB), a karst region in north-central Vietnam bordered on its western side by Laos. PN-KB was labeled a nature reserve in 1986. Fifteen years later, the site became a national park and, in 2003, became a United Nations World Heritage site (No. 1062/2013/QD-TTG 2014; UNESCO 2016). Today, it is a designated protected area, consisting of a core zone of 123,326 hectares and a surrounding buffer zone of 221,344 hectares (Thanh 2012). The core zone is divided into three areas: a strictly protected zone, an area for ecological restoration, and a space for administration and tourism (Hübner et al. 2014; UNESCO 2016). Managed by Vietnam's National Park Management Board, PN-KB is also a designated tourism site, which hosts 500,000 visitors annually (Hübner et al. 2014).

PN-KB is contained within three districts of the Quảng Bình province: Minh Hóa, Bố Trạch, and Quảng Ninh. Within these districts, there are 13 settled communes with an estimated population of 65,500; interviews conducted as part of this study took place in five communes within the buffer zone. The PN-KB management board and headquarters are located within the Son Trach commune of the Bo Trach District (Figure 3.1) (Thanh 2012). Approximately 500 residents live within the PN-KB core protected area (North et al. 2016).

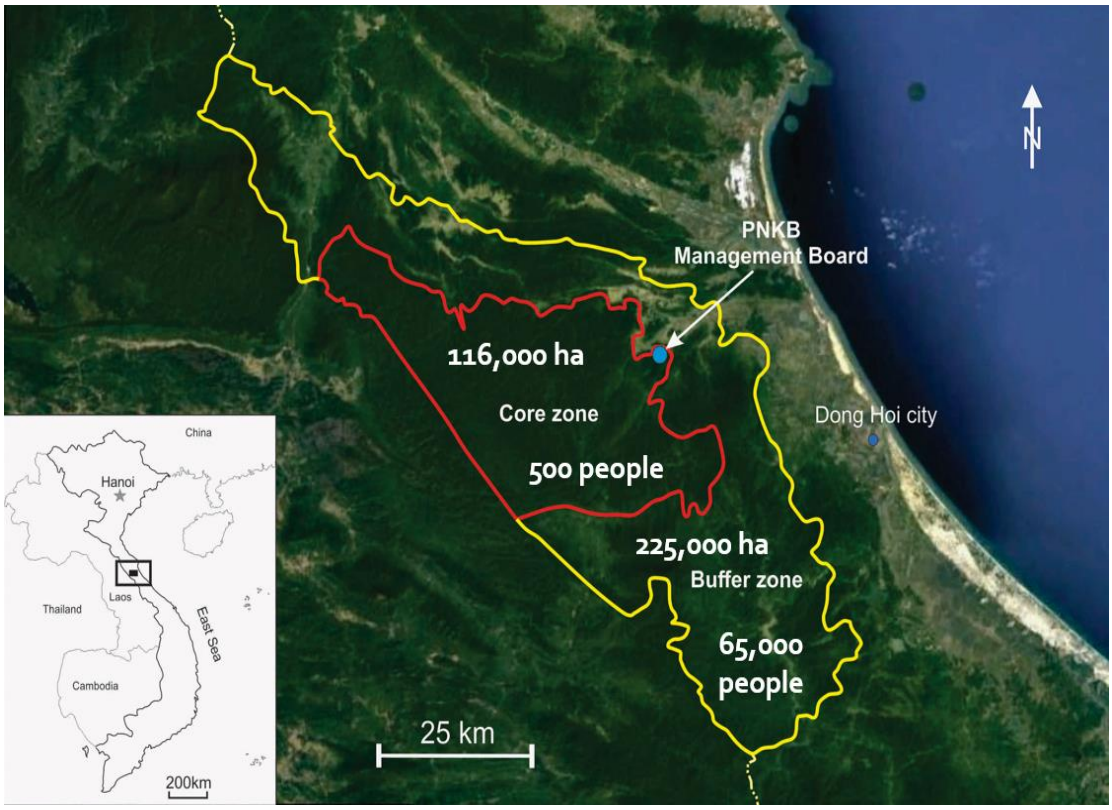


Figure 3.1: Map of Phong Nha-Kẻ Bàng National Park (Adapted from North et al. 2016).

3.1 Physical Geography

PN-KB has a tropical humid climate and lies within the Indochinese Rainforest; its average yearly temperature is 24 °C with a winter average of 18 °C and a summer average of 28 °C. PN-KB maintains high humidity with a yearly average of 84% and upwards of 2,500 millimeters of rainfall per year. The rainy season in central Vietnam falls between July and December, during which time about 88% of the region's yearly rainfall occurs (Thanh 2012). The vast rainfall noted in the country promotes Vietnam's extensive wet rice cultivation. Additionally, the monsoon climate contributes to the evolution of PN-KB's karst landscape.

PN-KB is located at the intersection of the Phong Nha, Kẻ Bàng, and Hin Namno karst systems (Thanh 2012; UNESCO 2016). The region is predominantly underlain with

Middle Carboniferous and Lower Permian limestone with small intersections of shale and sandstone, which is capped by schist and granite (Khang 1985; Thanh 2012). The extensive karst system within which PN-KB is located has evolved since the Paleozoic era and is the oldest karst area in Asia (Thanh 2012). The development of the karst system has occurred at a consistent rate due to the area's humid tropical climate. With temperatures that rarely drop below zero ºC, PN-KB's surface limestone formations are less vulnerable to freeze-thaw weathering (Khang 1985). Additionally, the extensive rainfall during Vietnam's wet season introduces high amounts of water to the local karst system. High levels of water infiltration mean that water flowing from the surface to subsurface infrequently meets $CaCO_3$ (calcite) saturation; unsaturated water maintains high dissolution abilities (Khang 1985). Typical of karst landscapes, the soils within PN-KB are thin. This is exacerbated in areas with less vegetation cover, such as cliff bluffs or areas cleared for agriculture (Tuyet 2011).

Many surface and subsurface features including towers, dolines, valleys, and caves characterize the limestone karst landscape in PN-KB. Deep dolines and closed valleys within PN-KB are evident of a cluster-depression landscape (Tuyet 2001). The landscape of PN-KB includes karst ridges up to 400 meters high and tower karst peaks reaching 1,000 meters. Within PN-KB are also narrow karst valleys; these valleys are often flooded during the wet season, but are almost completely dry from February to August (Thanh 2012).

In addition to its surface features, PN-KB also contains extensive and large underground cave systems. There are currently over 300 known caves in PN-KB, totaling over 104 kilometers of cave passageway and underground rivers (Management Official 4,

personal communication, 2017). The world's largest dry cave, Hang Sơn Đoòng, lies on the Sơn River and measures five kilometers long, 150 meters wide, and 200 meters high. Other caves within PN-KB vary between seven and 20 kilometers and include Phong Nha Cave, Thiên Đường Cave, Tiên Sơn Cave, Hang Khe Rhy Cave System, and the Vom Cave System (Thanh 2012).

The hydrology of PN-KB is defined by its surface and underground water systems. Groundwater emerges at a number of springs in the karst regions of PN-KB, including Mooc Spring. On the surface, the Son River is expressly responsible for the formation of Son Đoòng Cave and its tributary, while the underground Chay River is responsible for the formation of Phong Nha Cave. Many other rivers and streams flowing in PN-KB are tributaries of the Gianh River. Waterways throughout PN-KB are dominantly fed during the region's fall and winter wet season when the majority of precipitation occurs (Thanh 2012). The large majority of surface streams and rivers of PN-KB flow within the Park's non-karst areas, largely contained within the buffer zone (Thanh 2012). These surface streams are a large source of drinking and irrigation water for the population of PN-KB (personal observation, 2017). Within the core zone, minimal surface streams exist and the majority of water flows underground (Management Official 4, personal communication, 2017).

PN-KB residents place high strain on the karst features. Farming in dolines and valleys has disrupted soil formation, decreased soil fertility, and increased runoff and sedimentation, while flooding and irrigation for paddy rice production has disturbed the balance of water in underground rivers and aquifers (Tuyet 2001). Overall, there is a lack of comprehensive documentation of PN-KB's hydrology, water quality, and surface and

subsurface features (Management Official 4, personal communication, 2017). This lack of research negatively influences present efforts to assess natural or human-induced changes to the karst landscape and water resource quality.

3.1.1 Flora and Fauna

The core zone of PN-KB has approximately 99.63% forest coverage (Thanh 2012; Hübner et al. 2014). Forest coverage within the core zone includes tropical dense evergreen forests and tree and shrub savanna. In total, vegetation within PN-KB includes 2,851 plant species, of which 75 are defined as nationally threatened, 69 are defined as internationally threatened, and 12 are defined as globally critically endangered (Thanh 2012). Over 400 plant species in PN-KB are endemic to Vietnam; for example, about 1,000 hectares of limestone bedded areas in PN-KB above 700 meters are covered in the coniferous tree *calocedrus macrolepis*, a species endemic to the Vietnam's karst regions (Thanh 2012). There are 755 identified vertebrate species living within PN-KB of which 121 are mammals, 303 are birds, 161 are reptiles and amphibians, 170 are fish, 261 are butterflies, and two are endemic cave scorpion species (Tuyet 2001; Thanh 2012). While the management plan of PN-KB outlines the two endemic cave species, there is no existing literature on the amount or types of cave species within PN-KB.

As identified by the PN-KB management board, PN-KB's rich flora and fauna are at risk. Within the PN-KB core zone, activities such as logging, mining, hunting, and livestock grazing are strictly prohibited because of their negative ramifications on animal habitats, disturbance to natural wildlife, and disruption of forest rehabilitation. Despite their prohibition, these activities are still practiced covertly within the core zone and threaten the diverse biota and vegetation of PN-KB (Thanh 2012).

In the PN-KB buffer zone, significant urban development and farming has resulted in vegetation loss. While the forest of the buffer zone is not expressly protected by the management board, there exist projects within some communes to reclaim previously deforested land and plant native tree species. In some communes, this program has successfully reforested the region and provided employment (Park Resident 7, Commune 1, personal communication, 2017). In other communes, soils have not been able to support new tree growth (Park Resident 28, Commune 3, personal communication, 2017).

3.2 Cultural Geography

There is a rich human and cultural presence in PN-KB. The Park contains three districts: Minh Hóa, Bố Trạch, and Quảng Ninh. Each district contains a minimum of one commune (Figure 3.1). The population of the PN-KB's core area and buffer zone totals about 65,500 people. All of the PN-KB communes are agriculturally based, low-income, and considered priorities for economic and infrastructure development (Thanh 2012). Urban development is increasing, but is currently contained within the Phong Nha Village of the Sơn Trạch commune.

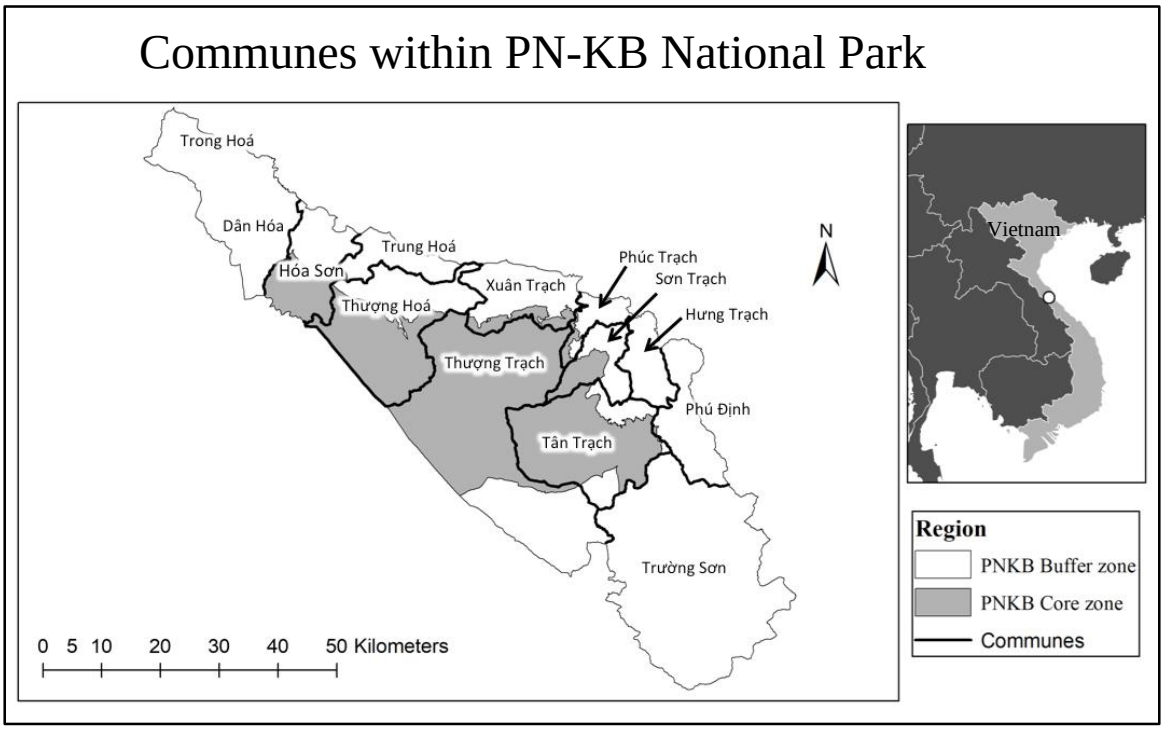


Figure 3.2: Communes within Phong Nha-Kẻ Bàng National Park (Created by author).

The PN-KB core zone is home to the Tân Trạch commune, within which there are two remote villages. Đoòng Village contains six households totaling 35 people, all representing the Vân Kiều ethnic group (Vu Thi Minh Nguyet, personal communication, 2018). The second village within the core zone is Arem, a self-contained ethnic minority containing 79 households and 307 people (Thanh 2012). In the buffer zone, there are thirteen communes with varying populations and ethnic makeups. The numerical distribution is outlined in Table 3.1 and PN-KB's human population density is shown in Figure 3.3.

Table 3.1: Districts and communes within Phong Nha-Kẻ Bàng National Park (Adapted from Thanh 2012).

District/*Commune*	**Area (Hectares)**	**# of Households**	**# of People**	**People per sq. km**
Minh Hóa	**98,605**	**3,831**	**17,154**	**32**
Dân Hóa	*17,697*	*834*	*3,519*	*19*
Hóa Sơn	*18,031*	*369*	*1,607*	*9*
Thượng Hoá	*34,634*	*706*	*3,105*	*9*
Trong Hoá	*18,789*	*693*	*3,636*	*19*
Trung Hoá	*9,454*	*1,229*	*5,287*	*55*
Bố Trạch	**167,606**	**10,300**	**43,838**	**190**
Hưng Trạch	*9,515*	*2,716*	*11,104*	*117*
Phú Định	*15,360*	*659*	*2,719*	*18*
Phúc Trạch	*6,022*	*2,478*	*10,761*	*178*
Sơn Trạch	*10,139*	*2,582*	*10,653*	*105*
Tân Trạch	*36,281*	*93*	*410*	*1*
Thượng Trạch	*72,572*	*461*	*2,457*	*3*
Xuân Trạch	*17,717*	*1,311*	*5,734*	*32*
Quảng Ninh	**77,384**	**929**	**3,972**	**5**
Trường Sơn	*77,384*	*929*	*3,972*	*5*
Total	**343,595**	**15,060**	**64,964**	**--**

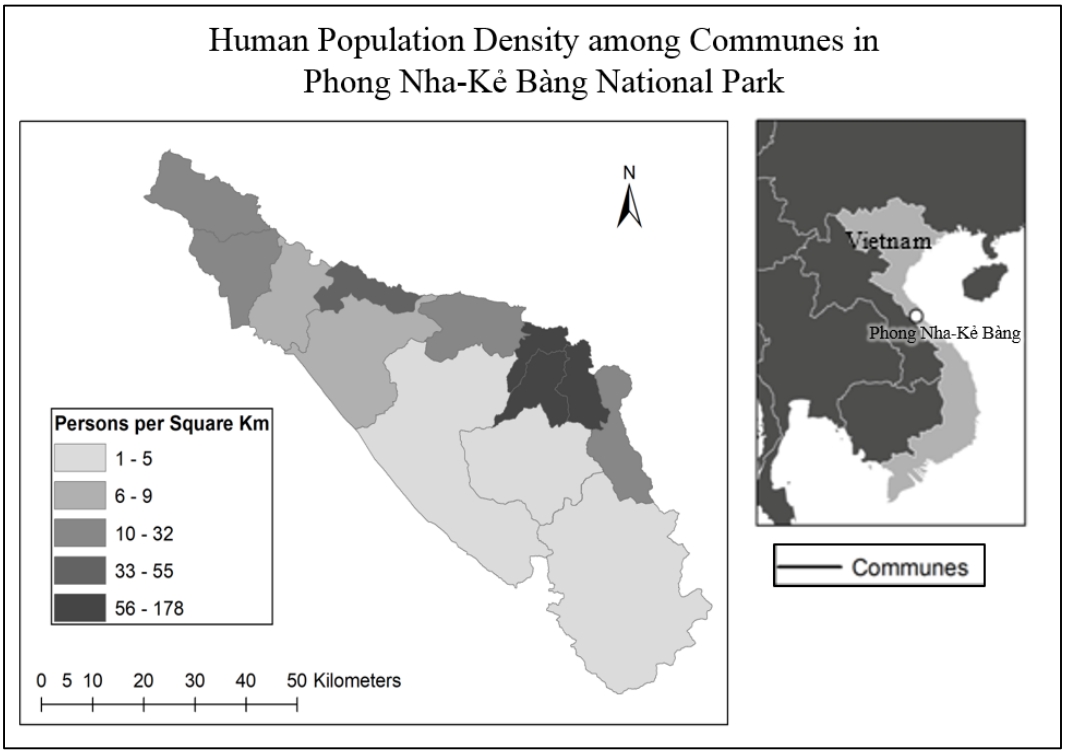


Figure 3.3: Human population density among communes in Phong Nha-Kẻ Bàng National Park (Created by author).

3.2.1 Ethnic Groups

Within PN-KB, there are three ethnic groups: the Kinh, the Vân Kiều, and the Chut. The Kinh is the majority ethnic group in Vietnam and are present in the majority of the buffer zone communes. The Vân Kiều make up the second largest proportion of people living in PN-KB. Sub-groups within the Vân Kiều ethnic group are present in the core zone's Đoòng village. Vân Kiều are also present in the buffer zone, populating the Thượng Trạch and Tân Trạch communes of the Bố Trạch district, as well as the Dân Hóa commune in the Minh Hóa district. The Chut ethnic group is the smallest in PN-KB region and contains both the Ruc and Arem peoples. The Arem people, whose name represents rocky caves and arches, are located within the core area. The Arem are the smallest ethnic minority within Vietnam. The Ruc people of the Chut ethnic group are

located within the Thượng Hoá commune in the buffer zone (Thanh 2012). While the commune location of each ethnic group is known, no data exists on the exact locations of these minority communities; moreover, there is no data on the spatial distribution of each ethnic group. Each of the ethnic groups in PN-KB has cultural and practical customs of its own. For example, while the Kinh and Vân Kiều predominantly speak Vietnamese, the isolated Arem and Ruc ethnic groups each possess their own distinct languages. The core zone communes are also small and isolated, resulting in limited inward and outward informational access; thus, broad ethnic and language variances between groups and the PN-KB management board can hinder communication and policy application (Thanh 2012; personal observation, 2017).

3.2.2 Agriculture

The farming families in Vietnam's north-central region, within which PN-KB is located, are largely reliant on agriculture; around 80% of households in the region depend solely on income from farming (Tuyet 2001; March and Macaulay 2006; Farming First 2009). Agriculture within the PN-KB buffer zone is permitted, but has little management oversight. Many crops are grown within PN-KB with each commune possessing a different dominant crop. Oftentimes, families are told or strongly influenced by the local government to plant certain crops (Resident 3, Commune 1, personal communication, 2017; Resident 7, Commune 1, personal communication, 2017). Crops grown throughout include paper trees, rubber trees, pepper, chili, rice, peanuts, corn, cassava, and various fruits. Within the Bố Trạch commune, where the largest population resides, paddy rice is the dominant crop and fields line large surface streams and rivers.

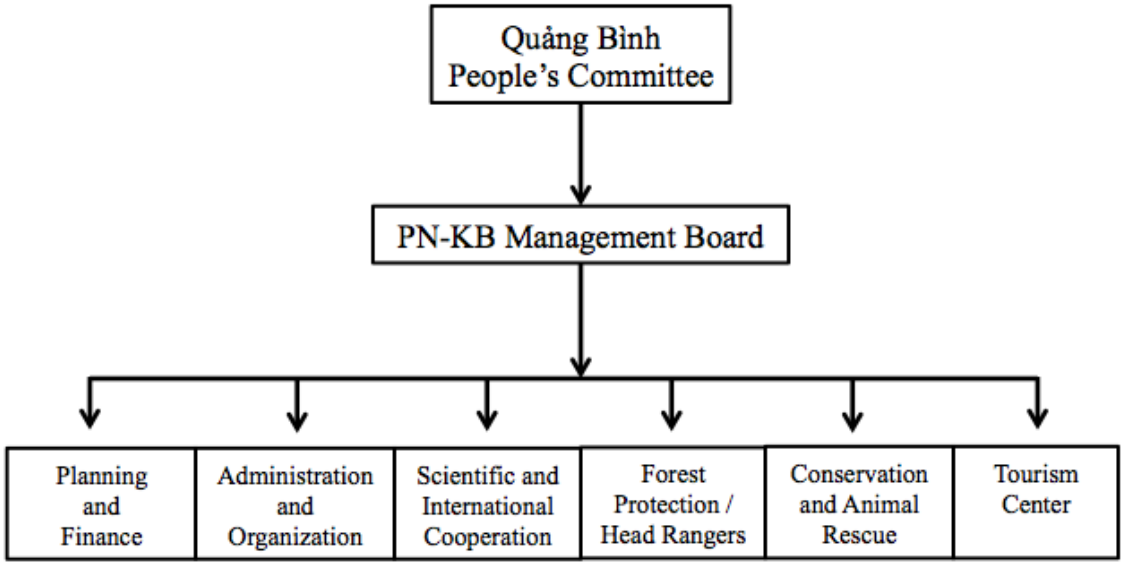
Agricultural practice on or near karst areas can widely affect surrounding terrain. For example, production of paddy rice involves extensive flooding of floodplains that allows rainwater to be collected. While this irrigation is natural, it can threaten the integrity of underlying karst aquifers and, in addition to soil erosion and runoff, result in a strained relationship between agriculture and the vulnerable karst terrain of PN-KB. Additionally, the widespread cultivation of rubber and paper trees negatively influences soils and water quality. Both rubber and paper trees grow out of sync with the local monsoon season, meaning that they experience most growth at the beginning of the dry season, thus using the majority of any water remaining in the soil. This results in dry, infertile soils and increased topsoil runoff in the case of rains or floods. While rubber and paper crops can have significant negative influences on the karst environment, the crops are much more profitable and in high demand; thus, farmers are more likely to plant these crops in spite of the downsides to their cultivation (Fox et al. 2014).

Overall, unmanaged farms in the buffer zone undermine the mission of the nearby protected area; however, the high population in the buffer zone, coupled with substantial reliance on agriculture for livelihoods, means that complete eradication of agriculture is not feasible (Hübner et al. 2014; North et al. 2016). Farming communities within PN-KB are subject to varying sources of information, which limits the amount of technological information entering communities and results in minimal spread of newer, safer agricultural techniques.

3.3 PN-KB Management

The PN-KB management board functions as a subsidiary of the Quảng Bình Provincial People's Committee, which approves the operational plan and budget

allocation of PN-KB. The PN-KB management board is tasked with overseeing activities within PN-KB boundaries (Figure 3.2). In 2012, the Board employed 356 staff with an operating budget of 1.5 million U.S. dollars (Thanh 2012).



Thanh 2012).

PN-KB is divided into three areas with separate administration systems: a strictly protected area, a forest rehabilitation area, and an administration area. Approximately 83% of PN-KB is defined as 'strictly protected' and 16% of PN-KB is defined for 'forest rehabilitation'; both areas are subdivided and assigned staff and rangers to ensure close management of park resources. Within both of these areas, various and extensive human activities are prohibited (Thanh 2012). The PN-KB management board identifies increased tourism in these protected areas as a threat to PN-KB's karst landscape, flora and fauna, and internal communities (Thanh 2012).

The budget for PN-KB is dispersed among six programs: (1) Protection and Conservation, (2) Sustainable Tourism Development, (3) Education and Awareness Raising, (4) Biodiversity Survey and Monitoring, (5) Strengthening Capacity, and (6)

Transboundary Cooperation with Hin Namno in Lao. Funding for the management board has consistently declined over the years which has negatively affected the development and application of park programs (Thanh 2012); the PN-KB management board reports a general lack of staffing and diminished capacity of its current human resources capability. For example, while there are many rangers, only 15% are trained to enforce rules within the protected area (Thanh 2012). This means minimal support services are available to resident of PN-KB, including an overall lack of educational efforts geared toward agricultural and karst resource responsibility (Hübner et al. 2014). Due to subpar management by rangers, illegal forestry and the use of natural resources still occurs within the core protected area (Hübner et al. 2014). Additionally, while agriculture is allowed in the buffer zone, its practice is minimally regulated. According to North (2016, personal communication), an overall lack of trained rangers and human resources within PN-KB make local policy application difficult. In short, while PN-KB seeks to preserve karst lands, there are still numerous threats to resource and land preservation.

3.5.1 Tourism

Tourism to Vietnam has increased rapidly over the past decade (Figure 3.5). The country saw over ten million international visitors in 2016, a 26% increase since 2015 and 179% increase since 2006 (Vietnam National Administration of Tourism 2017). Between January and April of 2017, over four million international visitors entered Vietnam (Vietnam National Administration of Tourism 2017). While there is current data on the scope of present-day tourism into PN-KB, the data were not made available for this study; it has been suggested that tourism into PN-KB has increased drastically, with upwards of 5,000 tourists visiting show caves, such as Paradise Cave, and springs, such

as Mooc Spring, daily (North, personal communication, 2016) (Figure 3.6). Tourism into PN-KB is centralized around karst features. Oxalis Adventures is a private company offering organized cave and spring adventures to PN-KB visitors (Oxalis Adventures 2017). Oxalis does not currently offer information regarding the number of tourists that they guide through PN-KB yearly. Without specific data on tourism and largely separate management and tourism sectors, protection of PN-KB's landscape becomes more difficult. The PN-KB management board has ranked 'Destructive Tourism' fourth on its list of threats to PN-KB's biology, ecosystems, watershed, and karst landscape (Thanh 2012). Increased communication and cooperation among the PN-KB management board, Oxalis, and PN-KB residents is needed to ensure thorough understanding of the PN-KB karst landscape and the many avenues of protection that must be implemented in order to minimize human-induced degradation. This concept is further discussed in section 5.7.1.

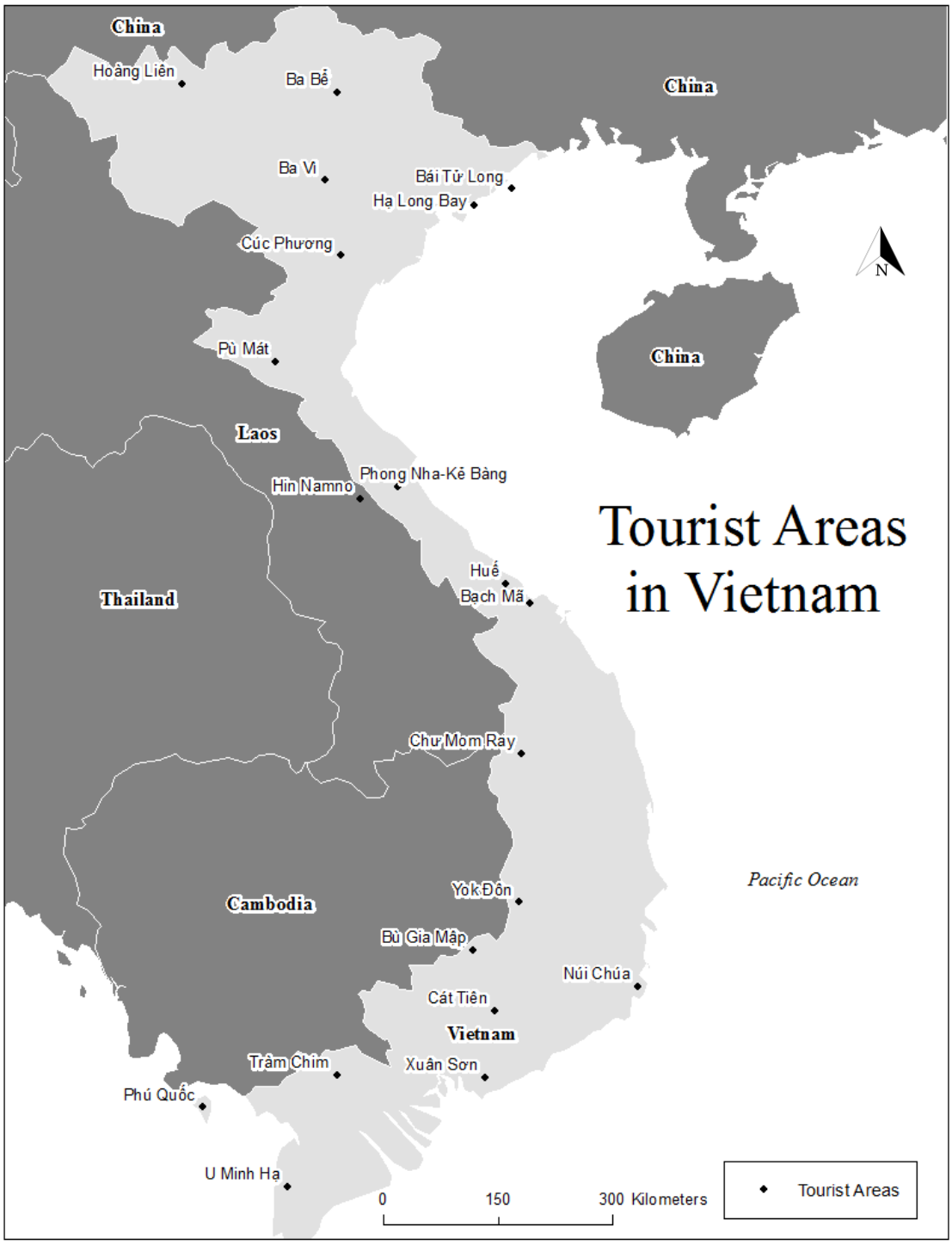


Figure 3.5: Tourist areas in Vietnam (Created by author).

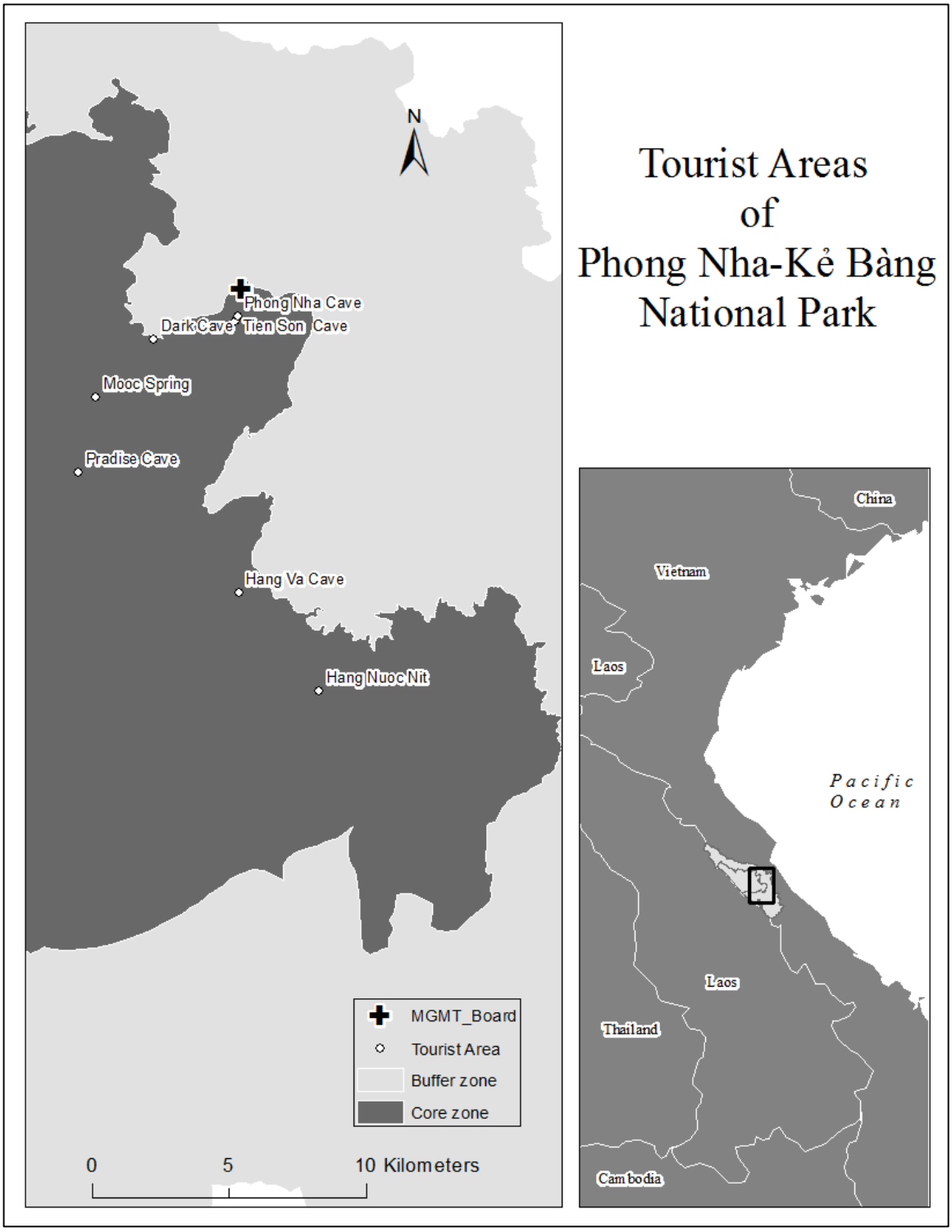


Figure 3.6: Tourist areas in Phong Nha-Kẻ Bàng National Park (Created by author).

3.6 Conclusion

Without support and education, there is limited effective communication between the agricultural communities and PN-KB staff (Thanh 2012). Effective policy implementation and educational efforts in PN-KB are further hindered through a lack of training for PN-KB rangers. Moreover, many rangers do not originate from the region within which PN-KB is located and, therefore, possess little connection to the land that they protect. The physical isolation of PN-KB's agricultural communities, in addition to cultural and communicative barriers between PN-KB personnel and community members, results in minimal education and, therefore, inadequate application of karst protection policies by the agricultural communities (North et al. 2016). When proper agricultural practices are not communicated, policies are not sufficiently implemented and agricultural practices used within the communities can continue to threaten diverse biota, extensive vegetation, and karst topography. For these reasons, Phong Nha-Kẻ Bàng National Park is a perfect case study site for better understanding how to identify constructive communication networks between the management teams and communities inhabiting karst agricultural communities. This information can then be used to better define and apply policy to not only protect karst areas, but also maintain the livelihoods of the individuals living in them.

CHAPTER 4: METHODOLOGY

This project used a qualitative approach to study karst land protection policies and the ways in which they are communicated in Phong Nha-Kẻ Bàng National Park (PN-KB), Vietnam. The case study included data collected through observations, semi-structured interviews, and analysis of communication flow using global positioning systems (GPS) and geographic information systems (GIS). Data collected as part of this study were used to explore how informal communication is currently used to disseminate information from PN-KB personnel to agricultural communities. Data analysis allowed for the exploration of if and how communicated information is understandable and appropriate for local social networks. Additionally, data collected through this study reveal how informal communication can be a tool to improve policy implementation in agricultural communities built on karst landscapes.

4.1 Data Collection

Semi-structured interviews and observations were used to gather in-depth data on social networks, communication patterns, and policy implementation in PN-KB. Materials used in this project included two digital voice recorders, two 32-Gigabyte SanDisk flashdrives, a Garmin Montana 680 GPS logger, a laptop, ArcGIS, Microsoft Excel, and note-taking instruments, such as a dedicated fieldbook. An employee of the Institute of Geological Sciences at the Vietnam Academy of Science served as an English and Vietnamese translator. Additional translation services were provided by the researcher's hired vehicle driver; this individual was a native to Phong Nha, a village within the Sơn Trạch commune.

Data were collected in PN-KB between July 10th and July 21st. Once in PN-KB, the researcher connected with three representatives of the PN-KB management board. These individuals worked with the translator from the Institute of Geological Sciences to create a list of ranger stations and communes within which interviews would take place. Before interviews began, the researcher provided the translator with interview questions and engaged in a brief training session on how interviews would be conducted.

Collected data were used to explore the following themes: 1) the success or failure of PN-KB policy to protect vulnerable karst land, 2) the success or failure of PN-KB managers and rangers to apply these policies, 3) the positive and negative consequences of these policies on agricultural communities, 4) the negative or positive influence of agriculture on karst land, and 5) the communication methods used to transfer information on karst land, agricultural practices, and implemented PN-KB policies. Collectively, these data allowed the researcher to understand each group's, and each individual's, unique perception of the relationship between karst lands, agricultural practice, and karst policy.

4.1.1 Observations

Qualitative methods were chosen for this project because of its focus on interpersonal communication, a field that is difficult to quantify (Maxwell 2005). Throughout the trip to the study area, the researcher and research assistant conducted observations. Areas of observation included: (1) physical park setting including karst land features, (2) agricultural landscapes and practices within PN-KB communities, (3) political and social structure within PN-KB communities, (4) communication patterns of the PN-KB management board, and (5) communication patterns within PN-KB

communities. These observations were completed based on a model outlined by Morgan et al. (2016). Observational notes were focused in two areas: location surroundings (weather, physical geography, culture) and formal and informal interactions. Observations of informal interactions focused on the interactions and routines exhibited by the people who populate the observed area.

At the end of each day, the researcher and research assistant reread the observations and electronically transcribed them. Dominant themes revealed during this process were used as a starting point for interview coding and created a context for the semi-structured interviews (Morgan et al. 2016). An investigation of landscape, communication, and body language created depth in qualitative research. The strengths and weaknesses of observational research methods are outlined in Table 4.1. Previous research on qualitative research methodologies has shown that observation, in addition to interviewing, allows each to be verified against the other (Morgan et al. 2016). When performed in conjunction, observations can help identify and diminish possible bias or misinterpreted interview responses (Maxwell 2005; Morgan et al. 2016).

Table 4.1: Strengths and Weaknesses of Observation Methods (Modified from Morgan et al. 2016).

Observational Methods	
Strengths	Weaknesses
Allows direct examination of behavior and activity in real time.	Time consuming and ethically challenging in some settings.
Provides information about topics participants may be unwilling to talk about, unaware of, or unable to recall.	Hawthorne effect – participants may change their behavior when they know they are being observed.
Undertaken in natural occurring contexts – allows examination of contextual factors.	Field note observations are influenced by what they observer chooses to record and analyze.

4.1.2 Semi-structured Interviews

In addition to observations, semi-structured interviews were used to collect qualitative data. Semi-structured interviews involve a basic script with broad questions that explore the interviewee's relationship, thoughts, and values towards the research topic (Leech 2002). The structure allows the interviewer to ask sub-questions and guide the interview without rigid structure. Semi-structured interviews flow similarly to conversations (Maxwell 2005).

The researcher conducted 68 interviews with residents and park personnel in order to achieve statistically significant data. Six interviews were conducted with employees of the PN-KB management board; they represented differing levels of management and different programs within the management board, including the Administration and Organization Unit, Forest Protection Unit, Planning and Finance Unit, Scientific and International Cooperation Unit, and Center for Conservation and Animal Rescue. These units included individuals who are responsible for outlining, financing, communicating, and enforcing the policies of PN-KB (Thanh 2012). During these interviews, the researcher and research assistant were accompanied by the translator, the driver, and two representatives from Western Kentucky University. The first two interviews with park officials were with singular individuals and the final interview was a group interview with four officials.

Twelve park rangers were interviewed in a series of group interviews (Figure 4.1). The ranger stations within which these interviews took place were chosen by the three planners from the PN-KB management board. They were located in diverse regions of PN-KB, including the buffer and core zones. Interviews with PN-KB rangers were

attended by the researcher, research assistant, translator, driver, and two representatives from Western Kentucky University. Rangers that were interviewed volunteered to participate but in all situations, the head ranger, that with the longest job tenure, volunteered and led in responses. Lower level rangers sat in and answered, but participated less.

Figure 4.1: Photograph of an interview with two park rangers. Additional individuals present include two research assistants, a translator, and a driver. Faces have been blurred for confidentiality (Photo courtesy of Dr. Jason Polk).

PN-KB communes within which interviews occurred were assigned by the planners from the management board, but residents interviewed within PN-KB were chosen randomly. On days when resident interviews occurred, the researcher and research assistant were accompanied by the translator, the driver, a representative from

PN-KB management, and, in Communes 1-3, a representative from the local commune government (Figure 4.2). While interviewing residents, the researcher, research assistant, translator, and PN-KB representatives drove around communes and chose random residents to interview. Fifty interviews with PN-KB residents were collected in a total of five communes. Original plans included interviews at a sixth commune located in the buffer zone, but monsoon rains the night before the interviews were to take place closed off the only road from which the village is accessible.

Figure 4.2: Photograph of an interview with a PN-KB resident. Additional individuals present include a translator, a representative from Phong Nha- Kẻ Bàng Management Board, a representative from the commune, and a driver. Faces have been blurred for confidentiality (Photo courtesy of Dr. Leslie North).

Before each interview, the interviewee was given a Human Subjects Review Board (IRB) approved stamped informed consent document written in Vietnamese

outlining the purpose of the study (Figure 4.3). The researcher and translator provided a verbal explanation of the project if needed by the interviewee. After the interviewee agreed to participate and signed the informed consent form, the interviews began. There was time to answer the interviewee's questions about the project before and after the interview. The specific interview questions were different for each group that was interviewed—officials, rangers, and community members. PN-KB officials were interviewed on their current management measures, perceived effectiveness, connection to PN-KB and its residents, and desires for future changes. Park rangers were also asked about these topics. Community members were interviewed with a greater focus on their current agricultural practices, communication techniques, and perceived connectedness with PN-KB managers.

Figure 4.3: Photograph of resident reading informed consent form. The resident was given time to ask questions or clarifications before signing the document. Faces have been blurred for confidentiality (Photo courtesy of Dr. Leslie North).

On average, interviews with PN-KB residents lasted 20 minutes, interviews with PN-KB rangers lasted 60 minutes, and interviews with PN-KB officials lasted 80 minutes. There was a mixture of open- and close-ended questions to keep the structure varied. Interview questions can be seen in *Appendix A.* During the resident interviews, other individuals, such as friends and family, sat in and often provided supporting commentary. Some benefits of having a third party present included increased interviewee comfort and additional input on interview answers (Esterberg 2002).

Each interview was recorded with two voice recorders to safeguard against technological failure. During the interviews, the researcher took brief notes on the day, time, socioeconomic and cultural factors of the location, the interviewee's verbal responses and nonverbal body language, and background activities. The interview questions were asked in English and then translated into Vietnamese by the translator or the driver. The interviewee's responses were spoken in Vietnamese and relayed in English to the interviewer by the translator or driver.

Each resident interview ended with a series of questions on the resident's demographic information including age and ethnic group. Research suggests that when demographic information is sought at the beginning of an interview, the interviewee may believe that their answers are being judged based on their identity. This can result in guardedness by the interviewee, thus restricting their comfort and hindering wholly honest and dimensional answers (Leech 2002; Maxell 2005). To protect their identifying information, all interviewees were assigned numerical identifiers. At the end of each day, interviews were saved to two separate flashdrives, a password-protected folder on the researcher's personal computer, and secure online cloud storage via Google Drive.

Semi-structured interviews were chosen as the primary data collection technique for this research for a number of reasons. First, their conversational nature allows easy transition between superficial and in-depth information in a relatively short amount of time. Semi-structured interviews are also more likely to ensure comfort of the interviewee; this, in turn, creates greater sense of trust, increased personal disclosure, and more detailed responses. Whereas structured interviews or surveys may only provide a small sampling of an interviewee's personal thoughts, semi-structured interviews allow a time and place for conversation to explore reasoning behind thoughts (Leech 2002; DiCicco-Bloom and Crabtree 2006; Cohen 2008). Moreover, because of their conversational tone, semi-structured interviews elicit deeper, more analytical responses from the interviewees (Leech 2002; Maxwell 2005; DiCicco-Bloom and Crabtree 2006). These answers, combined with observational data and themes, then yield more meaningful data because of the depth and familiarity that accompanies conversation-based interviews (Maxwell 2005; Morgan et al. 2016).

When combined with the researcher's observations, semi-structured interviews created a larger picture of the interviewee's thoughts and situations. Observations contained context for interview answers and create dimension within analysis (Morgan et al. 2016). Together, these two qualitative methods allowed the researcher to understand what actions are being taken to protect karst land, the thoughts about the actions by all parties involved, how the actions are applied, why they are applied as such, and how actions can be improved.

4.1.3 GPS Data Collection

The researcher collected GPS coordinates, called waypoints, of each interview location. Waypoints were also documented at the commune center. These waypoints were recorded with a Garmin Montana 680 GPS logger. Waypoints were imported into ArcGIS and the waypoints were translated into GIS shapefiles. From there, the researcher accessed a GIS base map of PN-KB and projected the individual shapefiles on this base map. Four different symbols were assigned to these points: one for interview locations, one for the commune offices, one for the ranger stations, and one for the PN-KB management board (Figure 4.4). Visual projection of interview locations was used to analyze physical assets or barriers to communication between rangers, officials, and residents. This map was also used to visualize general flow of information between commune offices, the PN-KB Management Board, ranger stations, and residents (Figure 4.5).

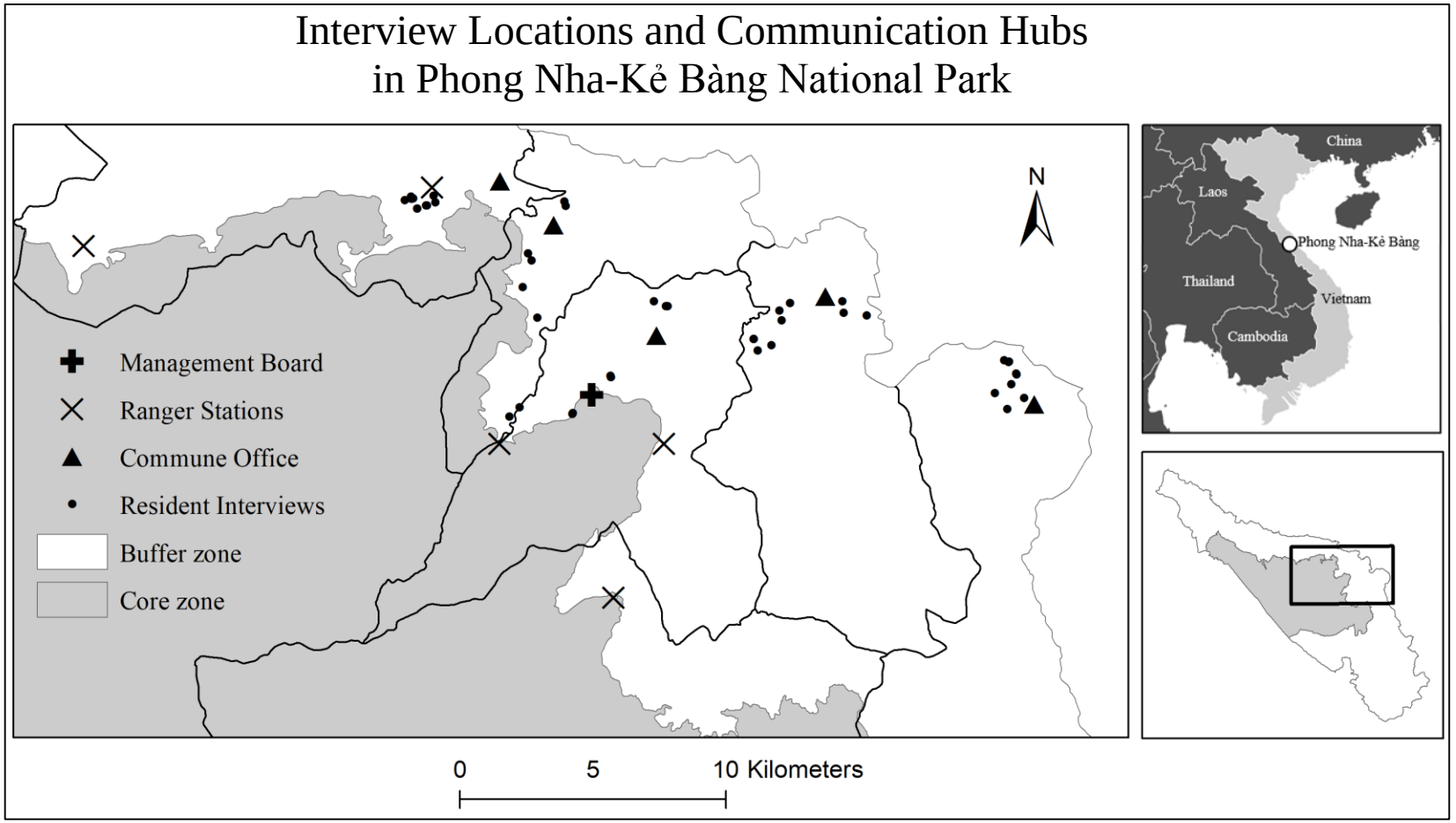


Figure 4.4: Interview locations and communication hubs in Phong Nha-Kẻ Bàng National Park (Created by author).

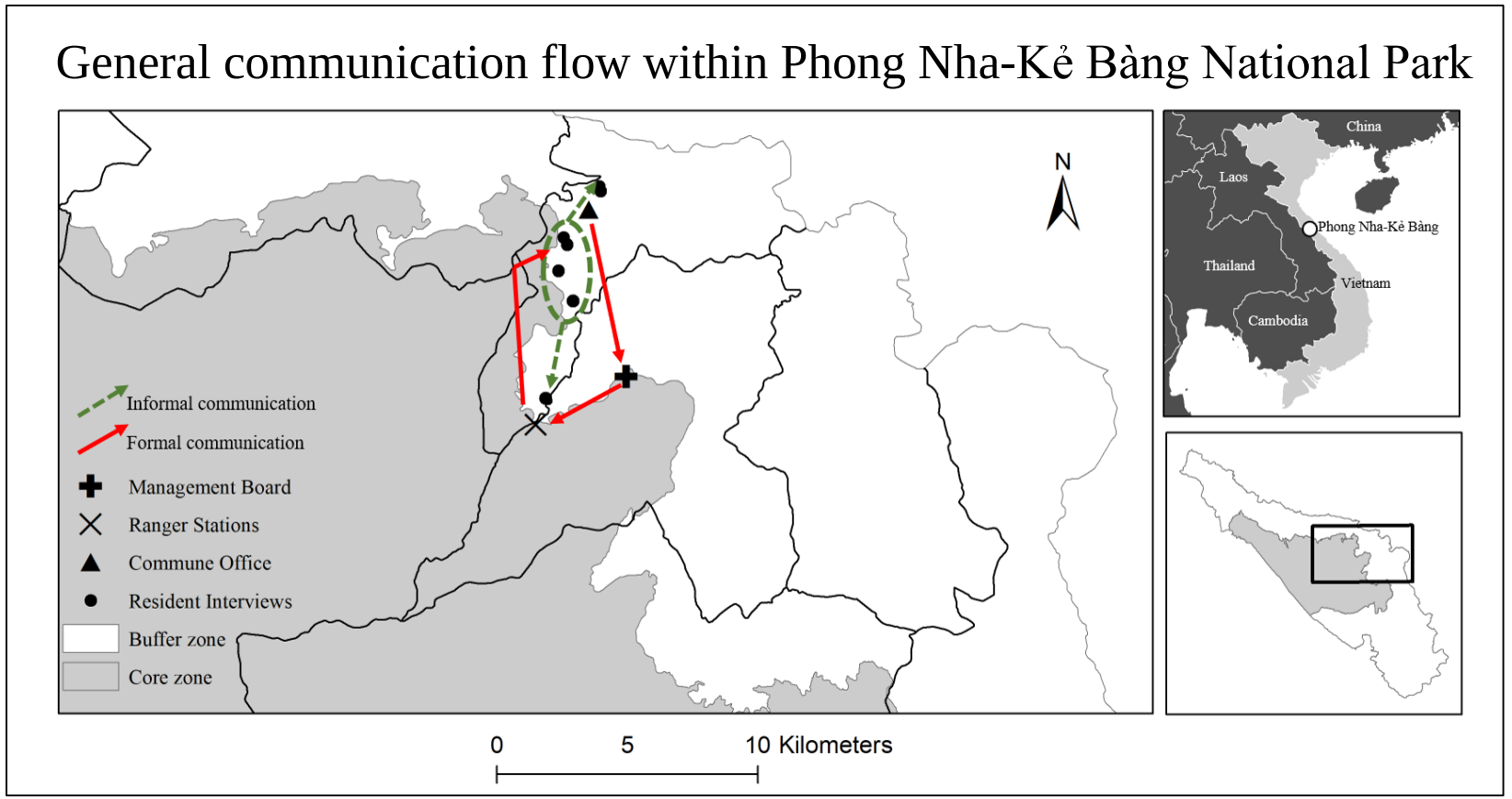


Figure 4.5: General communication flow within Phong Nha-Kẻ Bàng National Park (Created by author).

4.2 Data Processing, Interpretation, and Analysis

Interview transcriptions took place over one month after interviews were collected. Transcription occurred in Microsoft Word. During transcription, the researcher noted the interviewee's tone and background noises. These transcriptions and descriptions were compiled with corresponding notes from the interview session. Together, these data pieced together the spoken and unspoken contexts of the interview. These transcriptions and additional notes were saved to two separate flashdrives, a password-protected folder on the researcher's computer, and a secure online cloud storage via Google Drive.

Resident demographic information was entered into Microsoft Excel. The researcher used Excel to organize and determine the age, gender, and occupation distributions, as well as cultural representation, of residents. All resident demographic data were compiled and analyzed together. This analysis of demographics provided a cultural aspect when analyzing qualitative data. Lastly, GPS data were mapped in ArcGIS to reveal the spatial characteristics of the sample population and how these may influence communication between PN-KB rangers, officials, and other residents in the area. This analysis revealed physical and distance barriers to communication.

After transcription, the semi-structured interviews were read through twice without any markups. They were then combined with observations that occurred in the area in which the interviews took place. Next, the researcher coded the interviews by hand using a content analysis model (Esterberg 2002). Coding includes the reading and analyzing of interview data to identify and subdivide it into thematic categories. Themes found in preliminary observations are used to guide coding (Figure 4.6); however, these

themes only act as a springboard, in that other dominant themes may be revealed through the interviews (Basit 2003; Campbell et al. 2013; Morgan et al. 2016). While computer software may be used to code interviews, coding by hand permits the researcher to connect the data with past experience during observations and interviews (Basit 2003). Coding by hand allows the researcher to incorporate tone and body language into analysis (Basit 2003; Campbell et al. 2013).

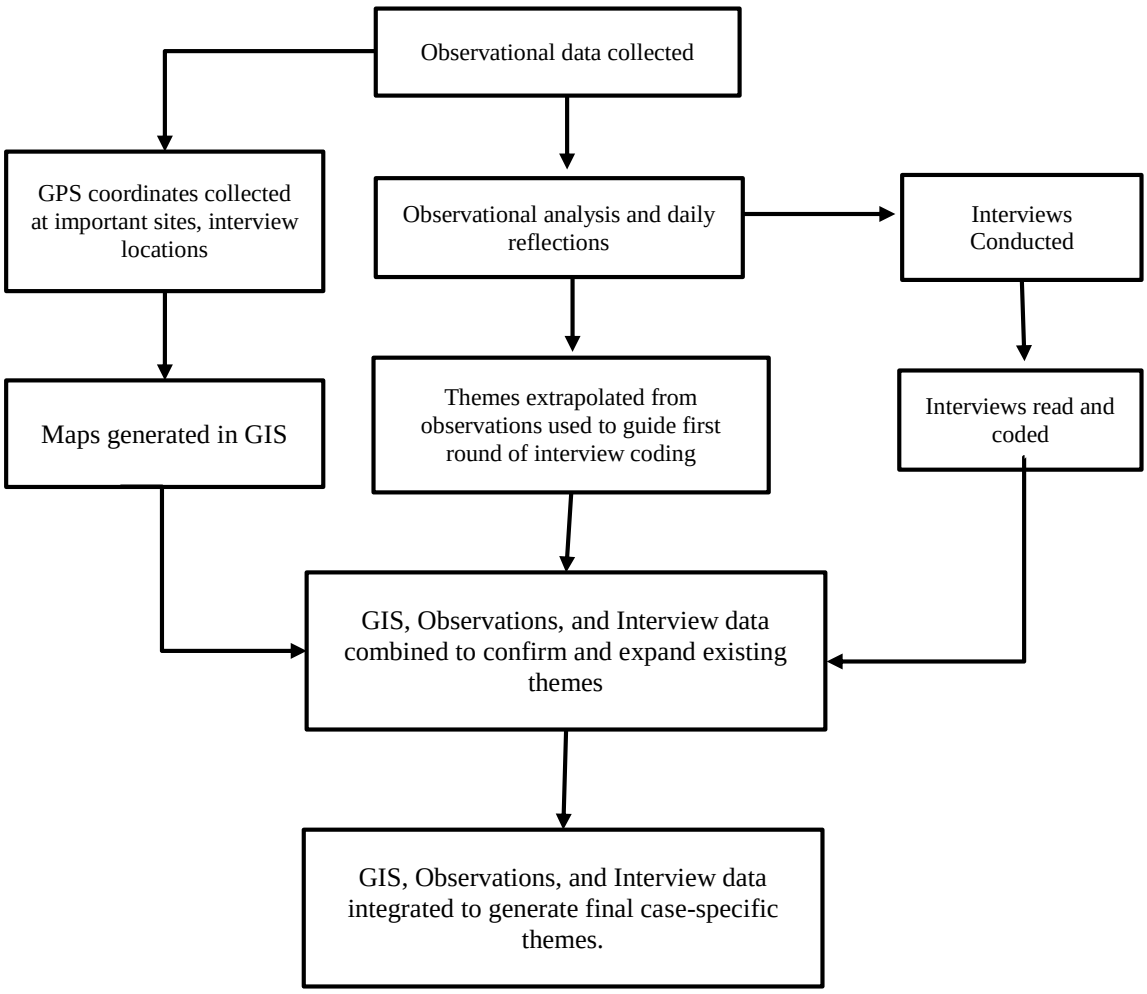


Figure 4.6: Framework for observational and non-observational data collection (Created by author).

Interview codes were analyzed twice. First, the researcher analyzed thematic codes separately, comparing each group—community members, officials, rangers—internally. This yielded data on each individual group and their unique thoughts, behaviors, and desires. Frequency and dominance of themes were entered and calculated in Microsoft Excel. All 68 interviews and their thematic codes were then analyzed as a whole group. Dominant themes were extrapolated, entered in to Excel, and calculated for frequency. Altogether, the coded dataset was used to identify experiences and themes specific to the interviewees; next, these were analyzed to identify broad theories that respond to the research questions (Basit 2003).

The researcher identified broad themes evident in the interviews and observations. These themes were interpreted through the model of analytic comparison outlined by Neuman (2000). This model includes Methods of Agreement in which each interviewee's views and experiences in relation to the broad themes were explored. Through Methods of Agreement, the researcher identified the outcomes symbolized by each broad theme and then located the common causes for this outcome identified in each interviewee's unique viewpoint on the broad theme (Neuman 2000). The different types or combinations of causes outlined were used to analyze the overall management and communication system between PN-KB personnel and residents (Neuman 2000). For example, if 'cultural barriers to communication' was identified as a broad theme, interviewee responses to this theme were analyzed in how they identified the causes of these barriers. Many respondents identify the cause as an ethnic mismatch between communicators. If respondents who identified the cultural barriers to communication also noted incongruent communication methods by PN-KB personnel, conclusions were

drawn that suggest the communication methods possessed by each community's unique ethnic group does not match with the ethnic group or communication method of the PN-KB personnel.

Overall, the Methods of Agreement approach was utilized to identify common issues in the communication and enforcement of PN-KB policy and the causes of these issues (Neumann 2000). Through this methodology, the researcher was able to identify crucial similarities between themes that dominate PN-KB personnel interviews and PN-KB resident interviews. Identification of these similar themes and causes yielded a data set that was generalized to create a comprehensive communication and enforcement framework that incorporated the needs and tendencies of both PN-KB personnel and residents (Neuman 2000).

4.3 Limitations of Methodology

This project comes with three major limitations: translation, distrust of the interviewer, and researcher bias. Working through a translator can result in simplification of topics (Opdenakker 2006); however, to ameliorate this limitation, this project employed the help of both a primary and secondary translator. In cases when the primary translator struggled to translate certain words or concepts, he would solicit the help of the secondary translator. Altogether, interview data, though translated, remained as original as possible. An additional limitation of semi-structured interviews is the possible distrust of the interviewer by community members. In this case, the researcher represented an outsider entering a previously established and cohesive community (Leech 2002; Maxwell 2005). To mitigate this limitation, the researcher was upfront and honest about the intentions of the project. The researcher provided an explanation of the project written

in easy-to-understand language and translated into Vietnamese. Any questions that interviewees had about the study were answered before the interview began or after it was concluded.

The overall purpose of a semi-structured interview design is to increase the comfort of participants and emphasize a conversational tone (Leech 2002); this, combined with the presence of many fellow Vietnamese people who live in the same area, reduced the amount of distrust or discomfort that the interviewee felt. Additionally, if an interviewee was unsure of participating, he or she was allowed to back out at any time. In some cases, interviewees decided after the interview that they did not want to be involved in the research and all of the data related with those participants were destroyed.

The design for this study may have been limited by the researcher's unknown bias. When making observations, taking notes, or leading an interview, there are many ways that a researcher can impose their own viewpoints. The researcher may only seek observations that support the research questions (Morgan et al. 2016). In order to mitigate this potential limitation, the researcher used the observational framework outlined by Morgan et al. (2016) (see Data Processing, Interpretation, and Analysis section). Overall, while there are limitations to the study's methodology, there are simple and effective ways in which they were mitigated and the researcher made every effort to implement them for the purposes of this study.

4.4 Conclusion

The data gathered and analyzed for this project were used to explain if and how methods of informal communication can be used to effectively convey karst protection policies. The research allowed for outlining the tradeoffs present between policies to

protect vulnerable karst land and the livelihoods of farmers who depend on that land. Dominant themes found during observation and semi-structured interviews allowed the researcher to map informal communication patterns between PN-KB community members, rangers, and officials. Altogether, these findings were combined in a formal recommendation to the PN-KB management board outlining potential changes to PN-KB policy that will promote both land protection and agricultural livelihoods. Additionally, recommendations were made on changes or supplementary actions that can be taken by PN-KB officials and rangers to increase effective informal communication into the PN-KB buffer zone communities.

CHAPTER 5: RESULTS AND DISCUSSION

This study was designed to explore the ways in which policy to protect karst landscapes is best communicated among agricultural communities using models of formal and informal communication. Semi-structured interview, observational, and GPS data were collected and analyzed for this study. Altogether, this study included 68 interviews with residents, rangers, and managers. Ten resident interviews occurred in five different communes, totaling 50 resident interviews. Of the fifty interviews, twenty occurred with females and thirty occurred with males; all fifty interviewees identified as Kinh ethnic group. Additional information on resident demographics can be found in *Appendix B.* Eleven ranger interviews occurred across five ranger stations; all interviewed rangers were male. At the PN-KB headquarters, six interviews occurred and all were with male officials. Each interviewee was assigned an anonymous moniker and a breakdown of these identifications can be found in *Appendix C.* Once interviews were coded, a preliminary content analysis of all interviews was used to identify dominant trends among interviewees (Appendix D; Appendix E; Appendix F). Table 5.1 shows the dominant themes among park officials, rangers, and residents revealed through this process. Tables 5.2 and 5.3 display general numerical representation of informational and communication trends among interviewed groups.

Table 5.1: Dominant Themes among interviewed population in Phong Nha-Kẻ Bàng National Park (Created by author).

Population	Theme
Residents	Frequent informal communication between residents.
	Minimal understanding of karst landscapes.
	Information flow through village meetings.
	Minimal communication with park rangers and officials.
	Mistrust and minimal communication with commune officials.
Rangers	Job is forest protection and community education.
	Preference for forest protection.
	Trained predominately on forest protection.
	Barriers to communication with residents.
	Far distance from communities served.
	Separation between core zone and buffer zone.
	Limited communication with management board.
	Minimal understanding of karst landscapes.
	Agriculture has no effect on park protection.
Officials	Minimal communication with rangers and residents.
	Park mission as forest and biodiversity protection.
	Shallow understanding of karst landscapes and resources.
	Park-wide meetings as crux of communication.
	Limited in-flow of scientific resources.
	Social hierarchy.
	Agriculture has a minimal effect on park protection.

Table 5.2: Frequency of dominant themes among residents, rangers, and officials. This table shows how many interview participants among each population spoke about each pertinent them (Created by author).

Topic	Residents	Rangers	Officials
Communication with residents	47	12	1
Communication with rangers	16	4	6
Communication with park officials	9	8	5
Communication with commune officials	7	2	5
Knowledge of caves	42	12	6
Knowledge of karst landscapes and processes	1	2	6
Knowledge of forest and biodiversity	11	12	2
Agriculture as a threat to park protection	0	0	0
Attendance at park-wide meetings	0	0	5
Attendance at village meetings	31	6	2
Participation or communication with tourism sector.	9	4	0

Table 5.3: Percentage of participants with categorical groups who discussed each dominant theme. The data are shown as percent of total interviewees for each category whom discussed each theme (Created by author).

Topic	Residents (% of total)	Rangers (% of total)	Officials (% of total)
Communication with residents	94	100	16.67
Communication with rangers	32	33.33	100
Communication with park officials	18	66.67	83.33
Communication with commune officials	14	16.67	83.33
Knowledge of caves	84	100	100
Knowledge of karst landscapes and processes	2	16.67	100
Knowledge of forest and biodiversity	22	100	33.33
Agriculture as a threat to park protection	0	0	0
Attendance at park-wide meetings	0	0	83.33
Attendance at village meetings	62	50	33.33
Participation or communication with tourism sector.	18	33.33	0

To further protect the identity of interview participants, personal communication citations throughout this chapter are broadly identified by location (e.g., management office, rangers, commune), rather than specific management board division or ranger station location. At each interview location, a GPS point was taken; additional GPS points were taken at commune offices. These locations were compiled into a map that was also used to inform the general spatial distribution of communication networks. Lastly, observations were taken daily in each interview location. These observations were used to guide interview coding and analysis.

Altogether, data gathered on communication methods can increase citizen comprehension of karst landscapes and protection policies and, therefore, be used to better protect vulnerable karst landscapes. Phong Nha-Kẻ Bàng National Park (PN-KB) was chosen as a study area because it is a UNESCO World Heritage site and a designated karst protected area. PN-KB was also used as the study area because the management of PN-KB operates with a compartmentalized communication structure and hierarchical management plan, both of which can be used to explore the necessary policy components and communication structure for utmost protection of karst landscapes. Additionally, around 80% of PN-KB residents practice agriculture for their livelihoods. Results from this study can be used to draw broader conclusions about the way in which formal and informal communication techniques can be used to increase understanding of karst processes by policymakers, land managers, and farmers, as well as to understand how karst protection policies around the world should be communicated for best protection of vulnerable karst landscapes.

Interviews were completed with PN-KB managers, rangers, and residents. Interview data were then coded and analyzed twice. For themes regarding specific topics or populations, frequency analysis was used. Throughout all interviews, responses within populations were very similar. For example, all resident responses to interview questions regarding communication and karst science information displayed minimal variation. The same is true for ranger and official interviews. To find broad and dominant themes that permeate all interviewed groups, Methods of Agreement analysis was used. These interview analyses, as well as observation and GPS analyses, were used to explore policy communication and comprehension of karst landscapes among PN-KB employees and residents. Results of this study suggest that communication structures within PN-KB are confined and minimal communication between management, rangers, and resident groups occurs. Additionally, management entities, such as officials and rangers, predominantly practice formal communication, which does not correspond to the informal communication techniques that dominate the citizen population. An additional obstacle in protecting the karst resources of PN-KB and communicating policies implemented in PN-KB is the lack of scientific understanding on karst processes among all individuals working and living in PN-KB. This limited understanding among the policymaking officials results in a policy that inadequately addresses the protection of PN-KB's karst resources. A lack of understanding of karst resources also extends to PN-KB rangers and residents, which results in sustained malpractice.

5.1 State and Local Political and Communication Structure of Vietnam

To understand how the policy in PN-KB attempts to function to protect its resources, the broad political structure of Vietnam must first be explored (Figure 5.1).

The Vietnamese National Government is responsible for nationwide policies; therefore, policies regarding the creation, funding, and maintenance of UNESCO World Heritage status for PN-KB originate at the national level. These broad polices are then delineated to provincial governments, who must then interpret and implement policies (McElwee 2002). The Quảng Bình Provincial Government determines the specific budget, policy requirements, and management staffing for PN-KB. Operating underneath the Quảng Bình Provincial Government are smaller scale commune offices and the PN-KB management board. The management board is responsible for generating a park policy that fits within UNESCO standards and guides day-to-day practices within PN-KB and to protect the resources. Within PN-KB, rangers and officials are responsible for applying park policy and executing outlined behaviors. The commune offices are an additional governmental force acting within PN-KB. Commune officials are responsible for applying provincial and local laws regarding taxes, businesses, and farming practices, among other things. Thus, residents living within PN-KB are subject to two separate law bodies: the management board and the commune office.

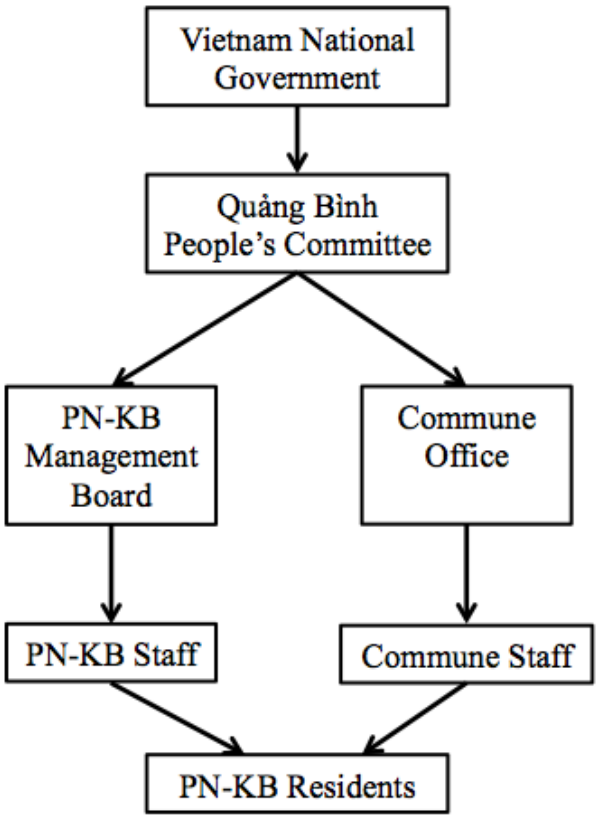


Figure 5.1: Political structure of Vietnam and PN-KB National Park (Created by author).

Communication among the political bodies in Vietnam and PN-KB is varied and often incongruent with the needs of both the political and citizen spheres. As outlined by Hoang et al. (2006), the communication of policy to government professionals is most successfully completed in formal settings such as trainings, meetings, or conferencing. While this ideal is met among the federal and state level policymakers, the use of formal training for local government employees, such as PN-KB managers and commune officials, is used sparingly and often not completed in a way to match the diverse knowledge bases (Figure 5.2).

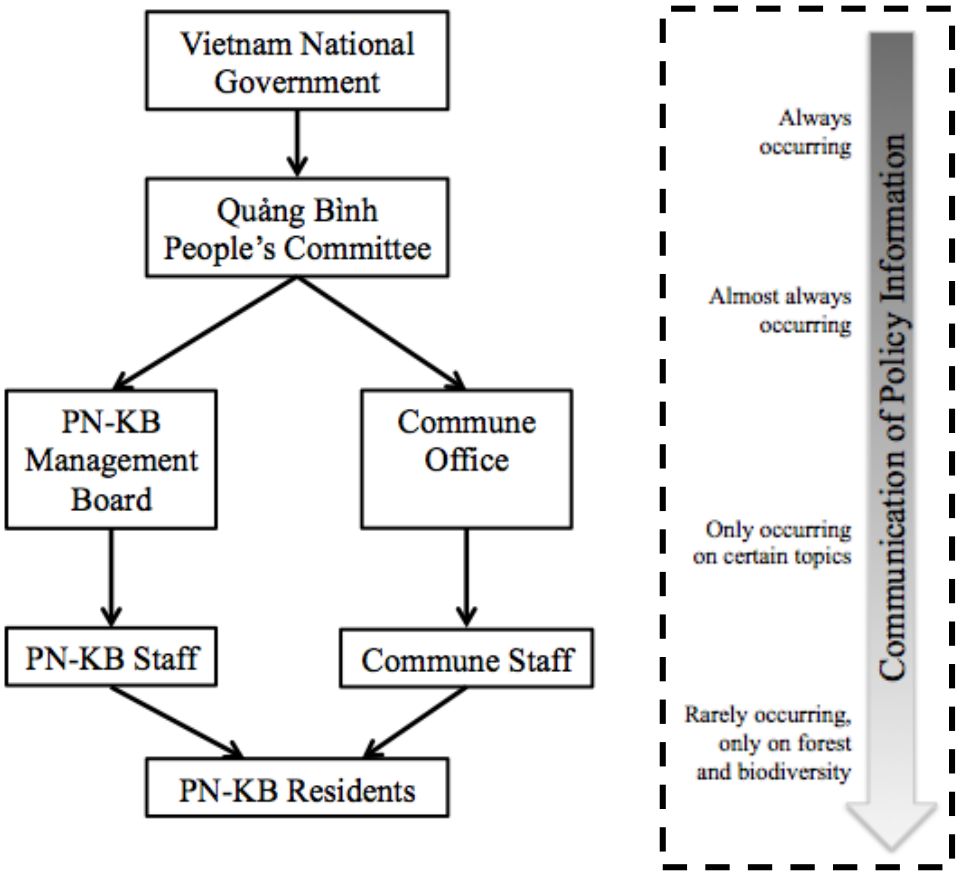


Figure 5.2: Political structure in Vietnam and PN-KB National Park. Dashed box highlights frequency and scope of communication (Created by author).

According to Management Official 4, who serves a senior position within PN-KB, large training meetings regarding policy within PN-KB are only held twice per year and contain representatives from the province, communes, and smaller villages (Management Office, personal communication, 2017). During these meetings, only formal communication is used to convey information to a broad group of people with varying degrees of knowledge on politics, agriculture, geography, and national resource management. In offering only two broad meetings per year, the nuances of generating policy, understanding and protecting natural resources, and coordinating diverse

communities are often overlooked for larger, more pressing issues, such as budget, employment, and forest protection. Thus, the infrequency of communication between political groups and overly broad scope of focus during meetings results in inadequate policies, minimal influx of outside information, and confined communication networks. For example, while PN-KB is well-known for its extensive cave systems and karst towers, there is limited understanding of karst landscapes, science, and processes among park employees. All interviewed PN-KB officials knew the word *karst*, but all six also failed to provide a functioning definition of the term or connect the geologic and biologic importance of PN-KB to the karst landscape and processes. According to Hoang et al. (2006), this functional information is what should be presented and discussed among government and managers; however, the broad scope and infrequency of meetings overlooks this crucial, functional information, thus resulting in ill-informed policy, uninformed employees, and sustained degradation of karst landscapes.

5.2 Political and Communication Structure in Phong Nha-Kẻ Bàng National Park

The management policy of PN-KB, published in 2012, is a document that provides background on PN-KB and its resources, information on the park population, current natural resource management practices, areas for improvement, and future management goals. Through analysis of this document and data provided by Management Official 4, this policy lacks any mention of its karst landscape in its list of management goals and practices (Management Office, personal communication, 2017). While there is discussion of karst landscapes among the document's background section, this brief discussion is confined to caves, rivers, and towers with no mention of specific karst processes or its influencing factor in biodiversity. Furthermore, none of these topics are

outlined as management goals and the term *karst* is never mentioned outside of the background section; therefore, the managing document for PN-KB contains neither the scientific or legal precedent for protecting its karst terrain. This omission must be noted when analyzing the communication of policy for utmost karst protection, because without a description of karst landscapes and their protection, communication for best management is flawed even before beginning.

Within PN-KB, the flow of information on policy and karst landscapes is varied and largely dependent on available information, current policy, and social hierarchy. According to all interviewed management board officials and Rangers 7 and 8, the influx of scientific information is dependent on the amount and type of outside researchers working in PN-KB (Ranger Station 3, personal communication, 2017). Thus, PN-KB itself does not actively conduct research on its karst landscape and relies only on the information provided by outside researchers. This lack of scientific conversation results in a staff and policy that overlooks obvious and extensive karst features of PN-KB; therefore, the unseen aspects of karst landscapes, such as the underground rivers and biota, go unprotected and the readily visible aspects of karst landscapes, such as caves, are embraced. Additionally, the forest and biodiversity of PN-KB is highly protected, but only against actions that are easily defined, such as poaching, burning, and logging; the unseen aspects of the forest, such as subsurface chemistry and processes, are highly influenced by the presence of limestone and karstification. Thus, without the karst landscape, the biodiversity and forest would not exist as it currently does in the region. Without an understanding of the relationship between the karst processes and flora and

fauna of PN-KB and appreciation for the importance of the karst terrain, the karst landscapes within PN-KB go largely unknown and unprotected.

Overall, communication structure and the influx of scientific information in PN-KB is strongly concentrated among the career political representatives at the management board and dwindles as information is passed to lower levels of the social structure (Figure 5.3). For example, 100% of management officials possessed information on general karst science; however, this information is rarely passed down, with only 16.67% of interviewed rangers and 2% of interviewed residents understanding basic concepts about karst landscapes (Table 5.3). As individual livelihoods diverge from the political realm, they are less likely to communicate about topics they see as political topics. For example, 50% of residents interviewed noted that they did not speak to PN-KB rangers or officials, because they simply had nothing to talk about to them. This is further supported by rangers who only mention talking to certain groups and not to their entire commune populations (Ranger Station 1, personal communication, 2017). The management board and rangers see their jobs as forest protectors, while the residents see their jobs, such as farming, completely separate from the mission of PN-KB. The specific communication tendencies of each subgroup within PN-KB will be further discussed next.

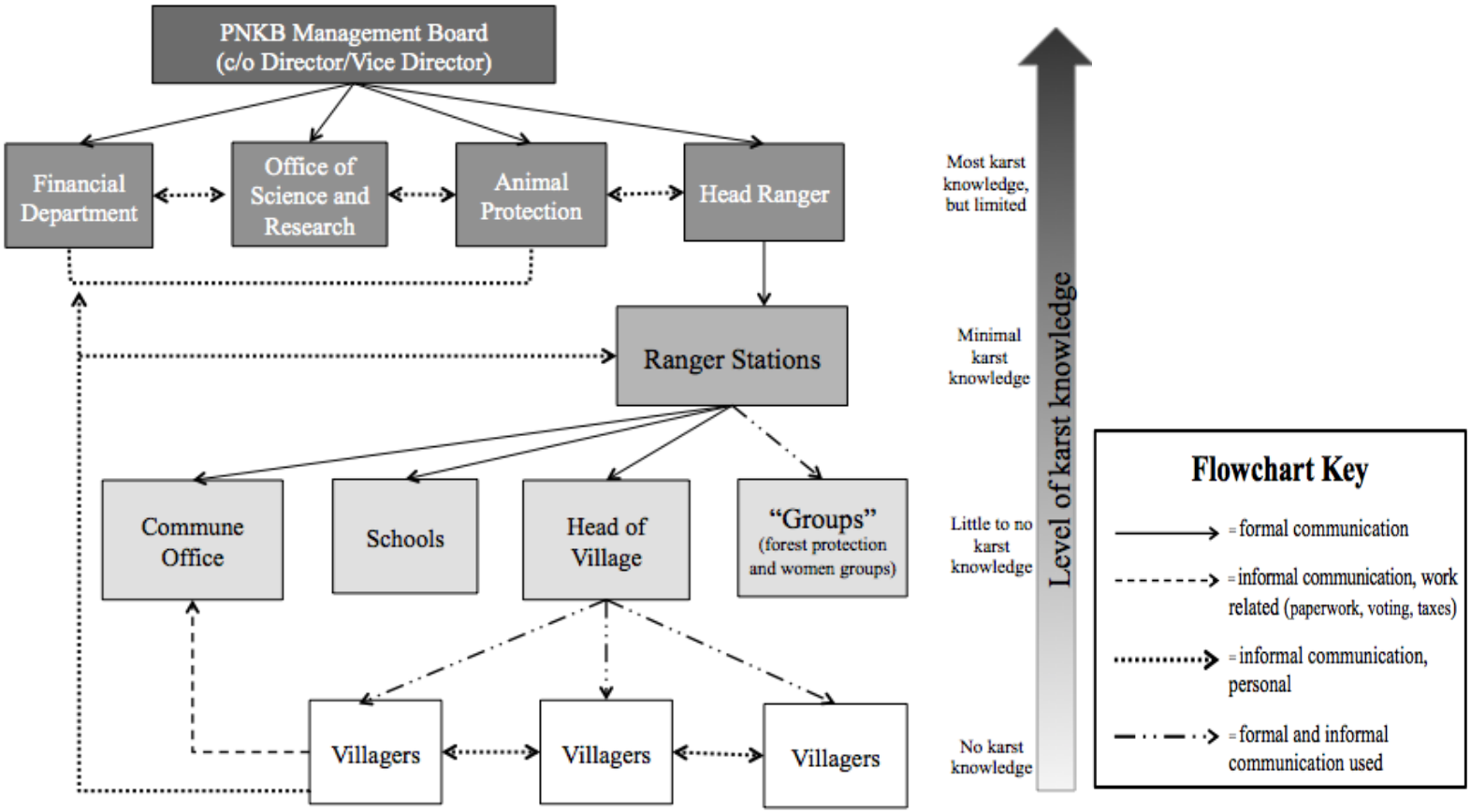


Figure 5.3: Communication flow and knowledge of karst landscapes within Phong Nha-Kẻ Bàng National Park (Created by author).

5.3 Communication Flow within Phong Nha-Kẻ Bàng Management Board

Officials working at the PN-KB management board are considered the highest social class of citizens living within PN-KB. As explained by Hoang et al. (2006), communication within Vietnamese communities is often confined by social class. This was confirmed to be the case within the social structure of PN-KB. As displayed in Figure 5.3, data suggest that the departments and employees at the PN-KB management board typically only communicate between themselves; communication between board employees and outside groups, such as rangers or residents, only occurs when specifically identified as part of their job duty or if the officials are related to another villager. Therefore, the only departments that execute communication with rangers, residents, or commune officials are the Head Rangers and the Animal Protection Division. While this communication does occur, it is typically only between these department and rangers and is done as minimally as possible.

5.3.1 Communication Trends among Phong Nha-Kẻ Bàng Management Officials

Communication by managers on PN-KB policies is confined to certain departments and to certain topics. The management facilities include three separate buildings that house the departments of the PN-KB management board. Thus, communication between departments is physically hindered and occurs only when necessary. All interviewed management officials mentioned that they communicate informally with their colleagues every day, but topics rarely involve PN-KB policy or management issues. Overall, interview and observation data both indicate that social and communication structure within PN-KB is strictly hierarchical, whereas horizontal communication occurs informally and vertical communication occurs formally. In

addition, upward communication, i.e. communication between an employee and supervisor, is not encouraged and oftentimes not received. Any vertical communication must be initiated by the communicator with a higher position.

Out of the four departments represented by interviewees, only one department—the head rangers—reported having frequent contact with rangers and occasional contact with villagers. All other departments reported periodic communication with rangers and minimal to no communication with villagers. Only 16.67% of the management board interviewees reported frequent communication with residents (Table 5.3); however, when officials did report communication with villagers, the communication was only with the heads of the local villages. Heads of villages make up roughly 10% of the local population and represent an intermediate social class.

The hierarchical communication structure and social isolation of PN-KB management officials undermines the successful communication of policy and may decreases board members' openness to outside scientific information. Without consistent communication between all levels of management employees, cohesion between departments is unlikely and the complete and unified application of an intricate and diverse park policy is impossible. Additionally, the social isolation of PN-KB managers sets an intimidating and often impenetrable boundary between themselves and park residents or outside information sources.

5.3.2 Information Access among Phong Nha-Kẻ Bàng Management Officials

The most consistent communication that occurs between PN-KB officials and rangers and local government officials takes place during the bi-annual meetings in which updates to park management are discussed. According to Management Official 4, park

residents are not invited to the bi-annual meetings. Instead, it is the job of the park rangers and local government officials at these meetings to feed the information to the resident constituency. While interviewed management officials stated that rangers attended the park-wide meetings, none of the interviewed rangers reported attending these meetings (Table 5.2); this finding suggests that the Head Rangers at the management board pass along information to local rangers instead of inviting them to the meeting. According to both ranger and resident interview data, however, the only information shared by the PN-KB Management Board is on the protection of the forest and biodiversity. The flow of information from this meeting to rangers is extremely successful, with 100% of interviewed rangers reporting that they fully understood the forest and biodiversity of PN-KB (Figure 5.3). Despite this success, interview data confirm that information on policy, governance, or karst landscapes does not permeate to lower levels of the social system. When asked whether bi-annual meetings discuss science or any aspect of karst landscapes, Management Official 4 explained that the meetings focus predominantly on updates in policy regarding forest and biodiversity management. Interestingly, the presentation of this material is highly successful in that the vast majority managers and rangers, in addition to roughly 22% of interviewed residents, understand why the forest and animals within PN-KB must be protected (Table 5.3; Figure 5.4). Interview data strongly suggest that this success can likely be attributed to the roles of officials and rangers and the plentiful information both parties hold regarding the forest and animals.

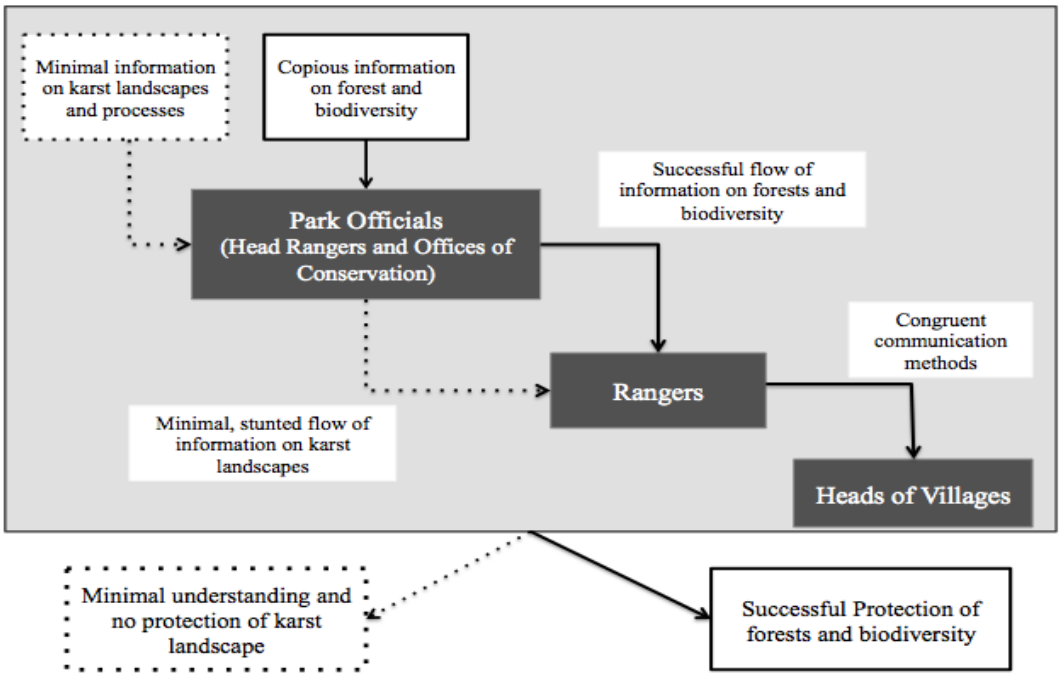


Figure 5.4: Inflow and outflow of information regarding karst landscapes, forests, and biodiversity in PN-KB National Park. Solid lines represent consistent, successful communication flow. Dotted lines inconsistent information flow (Created by author).

In addition to the large bi-annual meetings hosted by the PN-KB management board, Management Official 1, who is employed as a head ranger, discussed his department's use of community meetings to distribute any and all scientific information that is pertinent to PN-KB residents. He reports that within the first six months of 2017, his department held over 90 meetings with residents. While this information is correct, Management Official 1 incorrectly assigns this success to the actions of the head ranger office when, instead, it is the general lower-level rangers who are assigned with communicating scientific information to PN-KB residents. Though these reported meetings are occurring frequently, interview data suggest that their audience is extremely small and represents only a few residents. Specifically, during interviews, all twelve

rangers discussed their communication with village groups, heads of villages, and schools, but none of the rangers reported speaking in-person to any general villager or informally communicating with villagers. The only generalized communication that was accessible to most village residents was mentioned by Ranger 1 in which his ranger station would broadcast information via radio (Ranger Station 1, personal communication, 2017); however, this method favors a smaller, wealthier population with access to electricity and radio, which is further discussed in section 5.4. Moreover, while this is an open and accessible means of communication, no interviewed residents reported hearing ranger broadcasts (Table 5.2).

Throughout all six interviews with PN-KB officials, the topic of forests and biodiversity was mentioned roughly three times more often than the topic of karst landscapes. Additionally, information on karst landscapes was never introduced by the officials and was only discussed when the interviewees asked specific questions about the karst landscape of PN-KB. When karst landscapes were discussed with the PN-KB officials, the topics of caves and geology were most dominant and signified the areas where the PN-KB Management Board had the most information. For example, all six interviewed managers effectively described the number of caves within PN-KB, as well as their geologic age and rock type (Management Office, personal communication, 2017). Management Officials 1 and 4 could even describe the Park's limestone massif as Permian aged and the largest in South Asia (Management Office, personal communication, 2017). Despite this possession of information, it is still largely generalized and does not equate to a functional understanding of karst landscapes.

Despite partial understanding of general karst geology, officials either incorrectly identified or did not respond to questions regarding karst water resources and the interconnectedness of karst landscapes and the presence of endemic flora and fauna in PN-KB. The superficial information and common misunderstanding of karst landscapes was documented on two occasions during interviews with park officials. First, Management Official 1 inaccurately described the dangers of ingesting groundwater within karst aquifers. While Official 1 did understand that karst aquifers existed, that "limestone does not filter," and that the water within them had the potential to be contaminated, he described this contamination as a result of dissolved calcium carbonate within the water. When later asked if agriculture posed a threat to the water resources of PN-KB, Official 1 answered 'no.' Thus, Official 1 understands the geologic and hydrologic aspects of limestone, but lacks understanding of the processes that occur due to these aspects. This misunderstanding was also shown by Management Official 4 who discussed the presence of underground rivers, as well as the potential sedimentation and contamination of surface streams due to agriculture; however, Official 4 never mentioned the dangers of human actions and agriculture atop groundwater aquifers (Management Office, personal communication, 2017). This superficial knowledge of karst landscapes was also displayed by Management Official 2, who leads animal protection efforts within PN-KB. When discussing the importance of karst landscapes in relation to the forest and biodiversity, Official 2 could only describe the use of caves as shelter (Management Office, personal communication, 2017). Official 2 never examined the role of karst formed soils or karst water resources and their pertinence to the growth and vitality of PN-KB's unique flora and fauna (Management Office, personal communication, 2017).

Thus, these three officials lack any understanding of linking karst processes, such as the way in which surface water quality extends to the subsurface and cave environments (Management Office, personal communication, 2017).

As seen through these examples, the PN-KB management board contains minimal information pertaining to the karst landscape; additionally, PN-KB does not employ anyone identified as a karst scientist or expert (Management Official 4, personal communication, 2017). Without an individual or group tasked with gathering and assessing information regarding karst landscapes, the inclusion of this information within policy and management practices will continue to be minimal and, therefore, the education, communication, and protection for karst landscapes is unattainable.

Overall, the PN-KB management board contains individuals with the skill and capacity to fully understand the Park's karst resources, but their access to karst science is minimal. This issue is not unique to PN-KB and is common among karst protected areas around the world (Watson et al. 1997). Worldwide, karst protected areas are maintained by skilled and effective land managers but their mediocre understanding of surface and subsurface karst processes can likely be attributed to a lack of universally and publically accessible, comprehensible scientific resources about karst landscapes (Watson et al. 1997). Plenty of literature exists on surface and subsurface karst features, but this information is often concentrated among karst scientists or inaccessible due to language barriers or expensive pay walls (Watson et al. 1997).

In parks and karst regions without copious personnel or economic resources, the accessibility of these scientific resources is beyond reach, which causes misunderstanding and under-protection of karst landscapes, as is the case of PN-KB. In this case, PN-KB is

a perfect example of a global issue. While solving a global issue is beyond the scope of this study, PN-KB can begin to better understand karst processes and protection by seeking out universally accessible, free resources on karst science, such as the International Union for the Conservation of Nature's *Guidelines for Cave and Karst Protection*. Additionally, the management board can seek out research and results of researchers that have worked with PN-KB's karst resources. While a solution to the global integration of free and accessible karst science resources is a lofty future goal, PN-KB can take small, simple steps towards ensuring their own access to and comprehension of karst science.

5.4 Communication and Information Flow among Park Rangers

Data collected through this study revealed that park rangers in PN-KB serve as middlemen between the PN-KB management board and park residents. Thus, rangers are keystone players in vertical communication. Interviewees suggested that information from both parties—management and residents—must go through the rangers to the opposite party. All interviewed management officials reported speaking to rangers and 32% of interviewed residents report speaking to rangers; however, only 16% of management officials mentioned communicating with residents and only 18% of residents reported communications with park officials (Table 5.2; Table 5.3), indicating both officials and residents have more communication with rangers than with each other. Therefore, understanding the methods of communication utilized by park rangers is crucial towards comprehending how and why certain park resources are protected while others are unprotected.

It is important to note that the Vietnamese translation of *ranger* is directly linked to the idea of forest protection (Management Official 1, personal communication, 2017). Hence, just through the use of the term *ranger*, the scope of a ranger's job is immediately confined to one area. An additional confining factor to the role of park rangers is their understanding of PN-KB's core protected zone and buffer zone. Interview data suggest that rangers only define the core zone as the "Park" and that the buffer zone is considered just like any other land; therefore, the rangers only work to protect the core zone. When asked whether there are any threats to the health of PN-KB, no rangers noted any threatening behaviors in the buffer zone as threatening. Instead, rangers only noted threatening behaviors such as logging, poaching, and agriculture if these behaviors occur on the border of, or within, the core zone.

While protection of the core zone by rangers is important, protection of the buffer zone must also occur. The introduction of contaminants atop the karst landscapes of the buffer zone can have serious and widespread implication. For example, human or animal waste atop a karst landscape can leach into groundwater through soil leaching or sinkholes; since PN-KB's groundwater aquifer extends underneath the entire park and includes subsurface river flow through caves, contamination entering from human behaviors in the buffer zone can quickly extend to the highly protected and vulnerable core zone (Ford and Williams 2007). Knowing this threat, these preconceived ranger roles leave the entire PN-KB, both the core and buffer zones, vulnerable to unchecked and dangerous degradation including water contamination, threatened flora and fauna, unstable cave environments, and unstable surface land susceptible to subsidence.

When asked about the main duties for rangers, all interviewed rangers noted that the job was both forest protection and community education. They receive training on these topics from the PN-KB Management Board, but it was unclear how often these trainings occur. While consistency of meeting was unsure, it was clear that meetings between ranger stations and the managers only occurred when a problem arose (Ranger Station 3, personal communication, 2017; Ranger Station 5, personal communication, 2017). Furthermore, while rangers defined their roles as both educators and protectors, when asked which part of the job they preferred most, all rangers either directly or indirectly noted that forest protection was their favorite. Ranger 1 remarked that community education was "just a part of the job" and that he "has to do it." (Ranger Station 1, personal communication, 2017). Additionally, it became clear that community education focused almost exclusively on the forest and biodiversity. When asked whether the rangers discussed karst landscapes when educating the community, all rangers answered 'no.' It is likely that information on the karst landscape is overlooked simply because the rangers possess no information on the topic.

5.4.1 Communication Trends among Park Rangers

While hierarchy exists among park rangers, interviews with them reveal many more bilateral communication trends than with either residents or managers. Park rangers execute both horizontal communication among themselves and vertical communication between themselves, park officials, and park residents (Figure 5.5). At each ranger station within PN-KB, consistent communication occurs between rangers on a daily basis. This communication is predominately informal and topics include both personal life and work related items. When formal communication does occur between rangers, it is during

training sessions in which they are taught the necessary skills to be rangers. Formal trainings and upward communication with the head rangers or members of the PN-KB Management Board are done formally through meetings. The topic of these formal transactions is most frequently forest and biodiversity protection and methods for biodiversity protection. Interview data suggest, however, that rangers are trained on forest and biodiversity protection twice as often as communication methods.

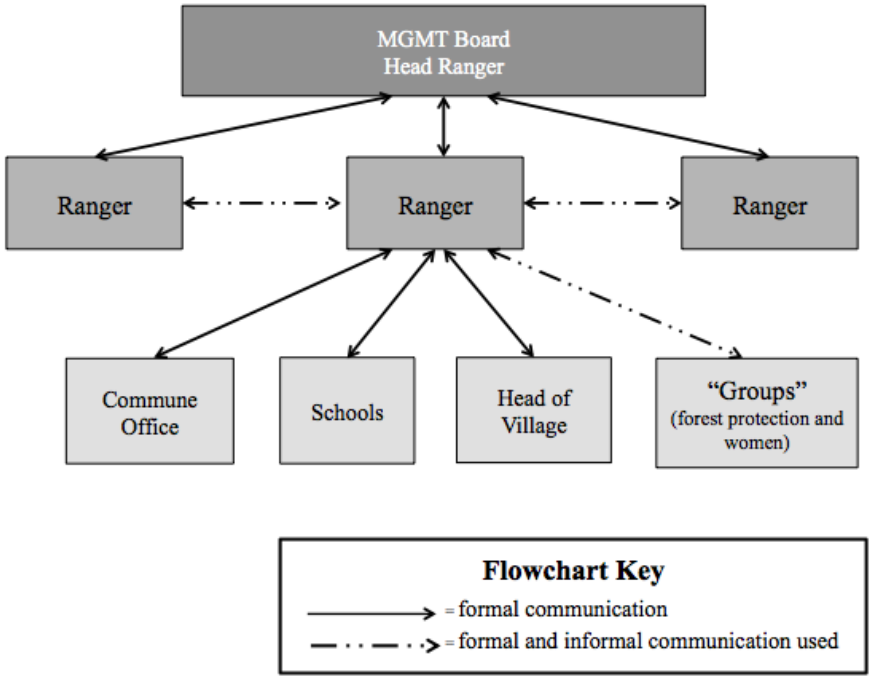


Figure 5.5: Communication trends between rangers, management board, and residents (Created by author).

The lack of training on appropriate communication methods results in downward communication between rangers and residents that is highly confined. Acting within their job description, rangers only note communication and trainings with school children, heads of villages, women's groups, and resident-led forest protection groups. Each

interviewed ranger at Station 1 also noted using radio as a means of communication, but this is also confining in that only residents with electricity and radios are receiving this information (Ranger Station 1, personal communication, 2017). Trainings with school children utilize resources on forest and animal protection such as books and posters; however, the books used are highly technical and would be largely incomprehensible by elementary and middle school children (personal observation, 2017).

The incorporation of resident-led groups within the ranger mission is important in that it encourages consistent understanding and communication between rangers and their communities; however, it was unclear as to how these resident groups are formulated and how members are chosen. Of the 50 interviewed residents, only one was a member of a forest protection group and one was a member of a women's group. These two residents reported frequent communication, both formal and informal, with rangers and other government officials. When asked whether these residents then spread the information provided by rangers, the individual in the forest protection group responded 'no,' while the woman in the women's group responded that the information is discussed but only within the group itself.

In addition to the resident-led groups, interviewed rangers also noted their communication with park residents through local heads of villages or village meetings. The interview data suggest that the meetings between rangers and heads of villages are often formal and the scope of information is again narrowed to only forest and fire protection. Half of the rangers reported attending village meetings, but data from resident interviews suggest that the frequency and scope of this attendance is extremely limited (Figure 5.2). While the information transferred between rangers and heads of villages is

minimal, interview data revealed that it is communicated well by the heads of villages. Information regarding the protection of the PN-KB forest and fire reduction has permeated throughout all classes of residents and this can be directly due to the role that the heads of village and village meetings play. This is further discussed in section 5.5.

Lastly, rangers report periodic communication with commune officials, but the information shared through this transaction is unknown. When speaking to park rangers at Station 3, they described meeting with the commune officers once a month (Ranger Station 3, personal communication, 2017). Collected interview data suggest that communication between commune officials and rangers focuses on the use of law enforcement to protect resources within PN-KB. Interviewees revealed that rangers and commune officials do not talk about karst landscapes or agricultural practices. Additionally, interviews with residents uncovered that agriculture was an issue completely in the realm of commune officials and that rangers are strictly there to protect the forest and animals. This lapse in communication is extremely important in that agriculture requires significant deforestation and altering of natural landscapes, thus forest protection and agricultural regulation must go hand-in-hand; however, the significant and extremely formal division in duties between the commune offices and ranger stations keep this information from being shared.

5.4.2 Communication Barriers

The communication trends among rangers, residents, commune officials, and PN-KB officials can be used to understand when and where information is being transferred. Nevertheless, there are many barriers to communication that hinder information flow between the ranger stations, management board, and park residents. These barriers are

both cultural and physical. First, over two-thirds of the rangers interviewed were either not born in the commune that they represent or were born outside of the Bố Trạch District. Thus, many rangers can be perceived as outsiders among the community that they serve. It was observed within resident communities that outsiders are often mistrusted or looked down upon. Thus, non-native rangers likely face significant barriers in establishing consistent, bilateral communication networks. An additional cultural barrier, though minimal, is religious identity. Two rangers at Station 4 noted that their community was divided Buddhist and Christian and that these religious differences serve as a barrier to successful communication when ranger religious preferences do not align with constituency religions (Ranger Station 4, personal communication, 2017).

Physical location of ranger station is the largest barrier to successful and consistent communication between PN-KB rangers and residents. This communication lapse was evident through ranger interviews, observation, and GPS analysis. During ranger interviews, rangers at stations 1 and 4 discussed how their offices were a long distance from residential areas and reaching these areas was extremely difficult during the rainy season. This physical barrier was also noted in observations when the research team could not reach a remote village, due to significant tree fall and road flooding the day after a large rainstorm. Currently, PN-KB and surrounding areas spend roughly four to six months in the monsoon season; thus, any communication between rangers and residents during this time is minimal or completely nonexistent.

The physical locations of ranger stations are not conducive to successful communication with park residents. As seen in Figure 5.6, the ranger stations are only located in communes that border PN-KB's core protected zone; this is likely due to the

commonly accepted definition as the “Park” only regarding the core zone and not the buffer zone. While the ranger stations are located at ideal locations for core zone protection, they are not located where the majority of the population lives – the outer communes of the buffer zone. Therefore, rangers are only set up to achieve one of their job duties: forest and biodiversity protection. With such high isolation from large segments of the population, rangers are unable to consistently and successfully communicate with, and educate, the community.

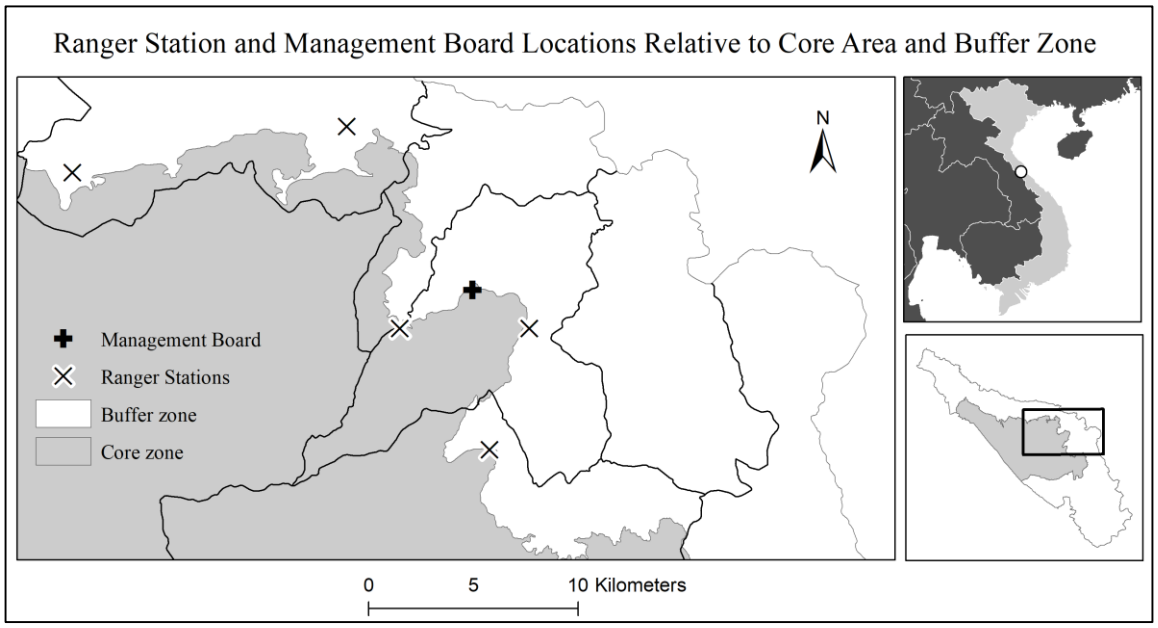


Figure 5.6: Ranger station and Management Board locations relative to core area and buffer zone (Created by author).

Despite noted occurrences of isolation between rangers and residents, an analysis of ranger station locations relative to villages was completed in ArcGIS and revealed that many ranger stations are within three to five kilometers of their constituency (Figure 5.7). Two ranger stations are even located in direct proximity to nearby villages. While mountain roads throughout PN-KB are winding, they effectively link all villages and,

during the dry season, are easily traversable by scooters and cars (personal observation, 2017); however, even during the dry season when all villages are accessible, rangers are not consistently visiting and communicating with their constituency. Research by Krishna et al. (2008) characterized the perception of distance by East Asians to be the same whether the observed distance was straight or convoluted. Both external research and this study suggest that park rangers understand that villages are only a small distance from the station. Therefore, lack of community education by rangers is likely not attributed to physical distance, but instead could be due to the rangers' preference for forest protection and dislike for, or discomfort with, community education.

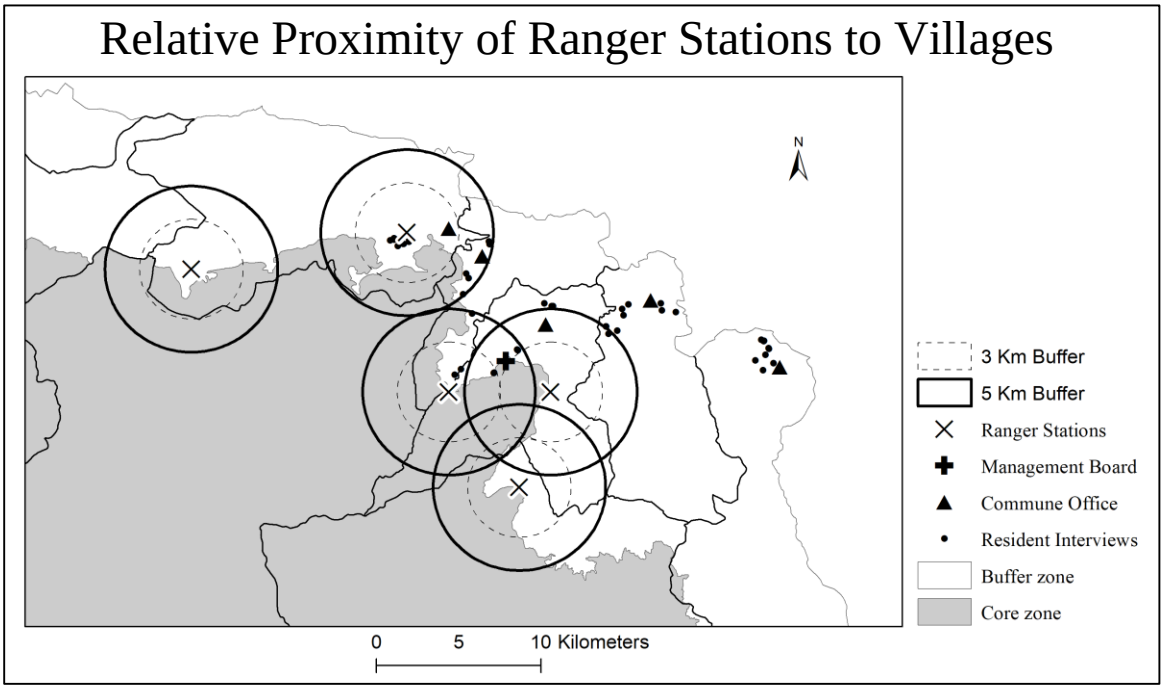


Figure 5.7: Relative proximity of ranger stations to villages (Created by author).

5.4.3 Information Access among Park Rangers

As aforementioned, communication between PN-KB rangers and management officials is often isolated and reactionary. The communication of scientific information between management officials and park rangers is dependent upon access to information by management officials. Interviews with rangers and managers reveal that scientific information regarding PN-KB's forest and biodiversity undergoes minimal changes and, therefore, the outflow of new scientific information to rangers is limited. Without a consistent source of information on forest and biodiversity statistics and science, rangers will continue to practice any and all currently known behaviors. Additionally, without sources of information regarding karst landscapes, the management board cannot effectively communicate on this topic. Specifically, with no in-flow of karst- or agriculture-related science into the management board, no information is available to reach the rangers; this can result in sustained land misuse; however, multiple interviewed rangers indicated an additional source of information is any scientists and outside individuals doing research within the core zone of PN-KB (Ranger Station 3, personal communication, 2017; Ranger Station 4, personal communication, 2017). Rangers accompany each research group entering the core zone of the Park; assuming that the ranger speaks the same language as the scientists, the ranger is free to bring this information back to their ranger station and commune. The frequency at which this exchange of information occurs is unknown and it is, therefore, impossible to understand whether outside researchers are a consistent or correct source of scientific information.

Other than researchers and PN-KB managers, rangers possess few avenues towards information acquisition. This deficit in information regarding karst landscapes

and agricultural practices, results in a ranger population that does not fully understand the land they are tasked to protect, nor the policies in place to protect it. Overall, rangers possessed significantly less knowledge on karst landscapes than the management board; only 16.67% of rangers expressed some level of understanding of karst science, compared to 100% of management officials (Table 5.3). While all rangers knew about the caves of PN-KB, only two rangers correctly described karst geology (Table 5.2). None of the interviewed rangers were able to discuss karst processes, karst water resources, or the interconnectedness of karst landscapes and flora and fauna. Without understanding of the land, rangers will be less likely to identify and stop human behaviors that cause harm to the protected landscape of PN-KB. Not only is this dangerous for the natural landscape, but it also threatens the very mission of PN-KB and its identity as a World Heritage Site and Protected Area. Despite minimal access to information from park managers, rangers transfer information between stations. All five ranger stations acknowledge that if they receive information regarding illegal activity, they will alert and work with other rangers, if that activity is transboundary between communes. Additionally, dedication to, and community organization for, forest and biodiversity protection among rangers is high.

Overall, while the vertical information flow in PN-KB is minimal, the networks already exist. Avenues for information flow between the management board and rangers exist in the forms of trainings and meetings, as well as a direct link to the Head Ranger. Between rangers and residents, links through heads of villages, school visits, and village meetings already exist. Utilizing these connections, rangers would be able to effectively deliver pertinent or new information to residents on a consistent basis. Thus, to increase

the consistence and success ranger communication, an increase in information and a complete understanding and utilization of existing communication networks must occur.

5.5 Communication and Information flow among Park Residents

In addition to rangers and managers, residents of PN-KB were also interviewed. Across all residents and communes, interview responses were for the most part uniform. Overall, 35 of the 50 interviewed residents identified as farmers and the remaining fifteen worked non-agriculture or commercial jobs. Each commune was subdivided into villages. Two interviewed participants acted as heads of a village and one acted as a vice-head of village. Social class and wealth were easily observable throughout all villages and communes. Observation and interview data also revealed that individuals with more money or many social connections possessed a higher social class and identified speaking most often with park staff. Residents who identified as farmers were more likely to have less wealth, possess a lower social class, and have less communication with PN-KB staff. Interestingly, unlike previous research on class in agricultural communities, it was not readily evident that the social class of PN-KB residents determines their social network size; both wealthy and poorer residents possess very large social networks (see Hoang et al. 2006; Khatam et al. 2013); therefore, while social class in PN-KB does not affect the size of social networks, it does determine which groups an individual may interact with and, therefore, which information is accessible to that individual.

5.5.1 Communication Trends among Park Residents

The vast majority of communication that occurs between PN-KB residents is informal communication. Unlike park officials and rangers, residents largely reported that

they communicate with fellow residents often and that these conversations varied in topics from everyday life, farming techniques, and PN-KB itself. Thus, residents were much more consistent and diverse in their topics of informal conversation. Additionally, residents' social networks are very large, often incorporating whole families and the families of neighbors; however, interview data suggest that these large, tightly woven informal communication networks only occur at the village level and sometimes between villages, but rarely across communes. The greatest information and communication link between villages and communes is the Heads of Villages who maintain relationships and frequently meet with commune officials and park rangers and bring broad park-wide information to their local constituencies (Figure 5.8). Heads of Villages are appointed to their positions, thus resident engagement in choosing Heads of Villages is minimal; this has the potential to create distrust between Heads of Villages and residents.

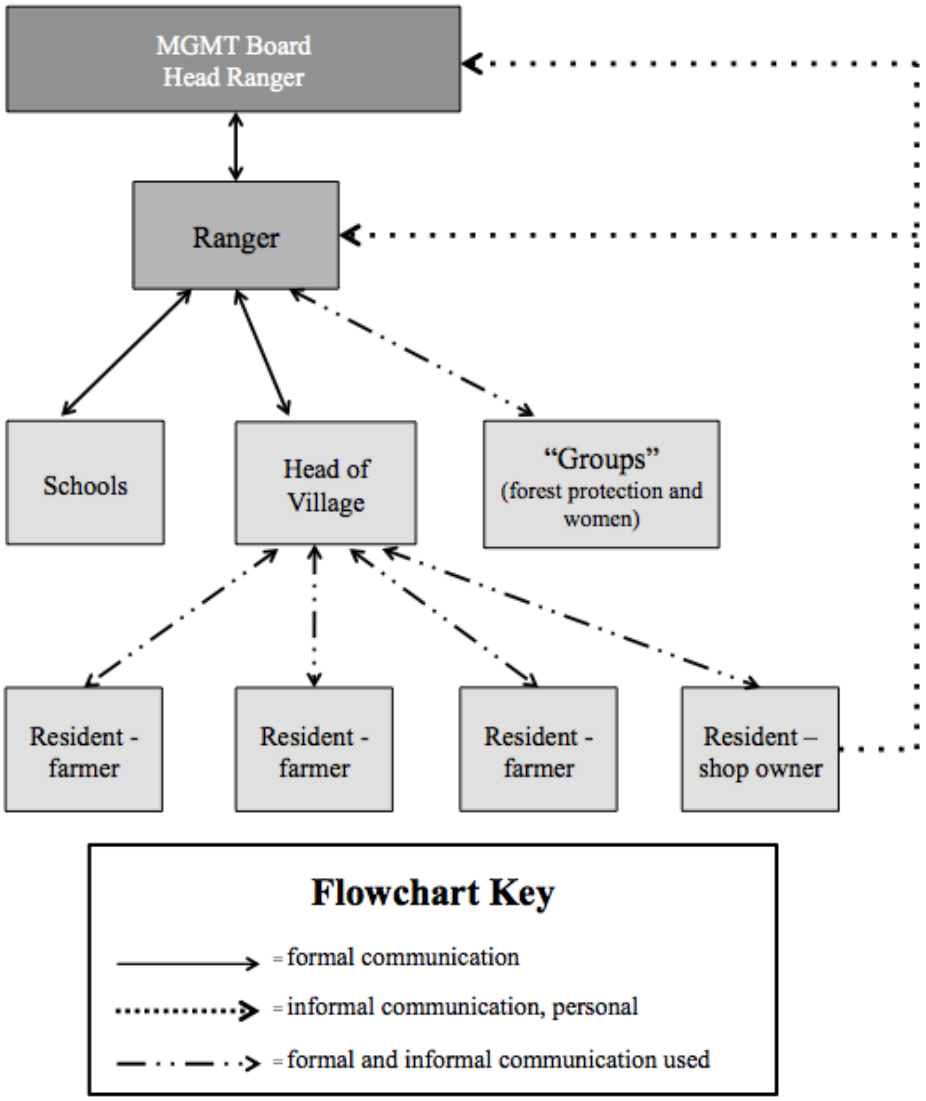


Figure 5.8: Communication flow influencing PN-KB Park Residents (Created by author).

Informal communication between residents is most likely to occur within homes, as displayed by Residents 15 and 16, who were friends and were interviewed together at the home of Resident 15. When asked how often they communicated with other residents, they laughed and responded "all of the time," pointing to each other. These residents were observed working together to make hats and discussing everyday matters such as family (Resident 15, Commune 2, personal communication, 2017; Resident 16,

Commune 2, personal communication, 2017). A similar situation was observed in every village, where interviewees would be accompanied in their own homes by family and friends, many of whom would also contribute responses to interview questions. When asked what residents discussed, the majority of interviewees responded that they discussed life and farming techniques.

PN-KB residents were also the group with the least experience in formal communication settings. Village meetings held by the Head of Village were the only instance where residents described engaging in formal communication. Overall, 62% of interviewed residents reported attending village meetings (Figure 5.3). These meetings varied in consistency between villages; during interviews, some residents reported village meetings occurring every month, while others reported only two or three village meetings per year. Topics of village meetings were also varied, including village security, village development and planning, crops to plant, chemicals and fertilizers to use, and harvest timetables. All of the information passed from the Head of Village to villagers during these meetings comes directly from the commune government, which has control over any development in the commune (Resident 7, Commune 1, personal communication, 2017; Resident 10, Commune 1, personal communication, 2017; Resident 44, Commune 5, personal communication, 2017). In some villages, park rangers may attend these village meetings. In Commune 2, Residents 15 and 16 report rangers attending their village meetings because their village was chosen to plant trees in an effort to reforest the land (Resident 15, Commune 2, personal communication, 2017; Resident 16, Commune 2, personal communication, 2017). The extent of communication between rangers and residents at these meetings is unknown, but interview data suggest that these interactions

are limited to forest and biodiversity protection and only occur in certain villages at certain times. Thus, communication between rangers and residents at village meetings is not a reliable source of information dispersion throughout all villages and communes.

Outside of village meetings, resident communication with perceived upper-class citizens—park officials, commune officials, rangers—is minimal and typically only occurs under certain conditions or situations such as familial relation, job meetings, or participation in a forest protection or women's group. Cross-class interactions are both formal and informal, but the transfer of information regarding PN-KB, its resources, and its management only occur during the formal communications. For example, residents working in forest protection are formally trained on how to protect PN-KB's natural resources (Resident 19, Commune 2, personal communication, 2017). Women serving in the women's groups communicate with rangers, park officials, and commune officials, but these only occur when allowed by the upper-class groups; Resident 25 explained that the concerns of the women and their constituency are addressed at only when initiated by the upper-class groups, the timing of which was often unpredictable (Commune 3, personal communication, 2017).

An additional source of formal communication occurs when rangers speak at local elementary schools. While these trainings were reported by the rangers during interviews, the occurrence of the meetings was contested by two interviewed school teachers who described that rangers only come to schools to informally interact with friends and sometimes teach children about communicating with tourists (Resident 18, Commune 2, personal communication, 2017; Resident 41, Commune 5, personal communication, 2017); therefore, it is unknown how often and to what extent rangers are formally

communicating with school children. In the case that educational meetings between rangers and children occur, the communication of PN-KB policy and forest protection to children is likely a much less successful way of spreading important information about PN-KB in that it relies on children to spread the information among themselves and their elders. No collected data reveal that residents received any information from their children regarding PN-KB's forest, biodiversity, or karst resources.

Outside of these schools, forest protection groups, and women's groups, communication between residents, rangers and officials is extremely limited. Only 18% of interviewed residents reported speaking to park officials, all of which reported this communicating as occurring through familial relationships or friendships (Table 5.3). Both Residents 9 and 16 spoke of how their family members worked as park officials, but both described that topics pertaining to PN-KB were rarely discussed in their informal interactions (Resident 9, Commune 1, personal communication, 2017; Resident 16, Commune 2, personal communication, 2017). When PN-KB is discussed, the conversation never focuses on park policy or management and only occasionally focuses on natural resources; discussion of natural resources is superficial and, for example, may only involve the discussion of the location or size of a cave (Resident 9, Commune 1, personal communication, 2017; Resident 16, Commune 2, personal communication, 2017). Overall, resident attitudes towards park officials and rangers are indifferent. Roughly half the interviewed park residents say that they do not currently communicate with any PN-KB staff and have no desire to initiate communication. For individuals who desired communication with park officials and rangers, the most common topics residents

wanted to talk about were the karst landscape and admission to local show caves (personal communication, 2017).

In addition to these communication links, there are also significant communication barriers between residents and other groups. As previously described, communication between residents, rangers, and park officials is often isolated and mismatched, leaving residents with little or no access to important information regarding PN-KB and its resources. One barrier to communication as reported by adult children and wives is that the male head of their household attends village meetings but does not communicate learned information back to his family (Resident 32, Commune 4, personal communication 2017; Resident 34, Commune 4, personal communication, 2017; Resident 50, Commune 5, personal communication, 2017). Not only does this isolate any agricultural or policy information to a solitary household member, but it also keeps important agricultural information from being communicated among neighbors. Throughout the data collection period, women were observed working on the farms and handling harvested crops, implying that women in PN-KB execute farming tasks similar to their male peers. Thus, women represent half of PN-KB's farming and residential population, but if information is not directly being given to these women, the likelihood that they will seek for information about important farming or policy concepts through communication with neighbors is minimal.

Communication between family members and neighbors is equally as common between both males and females in PN-KB, but the cultural tendency for information to be concentrated among male heads of households is an important threshold that can hinder effective policy and information communication. Without this informal

communication, adoption of policies or agricultural practices is less likely; further, without the support and guidance of trusted peers, it is less likely that an individual or family will change their behaviors (Hoang et al. 2006). While women and adult children cannot directly rely upon their spouse or parent for agricultural or policy information, other sources can be used to spread this information. For example, Commune 3 had a women's group that served the broad purpose of representing women's voices within park management. If the women's group hosted meetings or simply went door-to-door and presented important information pertaining to PN-KB, the informational gap between males and females could be bridged. Interview data suggest that providing women information regarding agriculture, PN-KB, or even karst landscapes will result in a greater spread of this information though informal networks. Despite this division in information access among women and men, interview data showed no other differences among profession, karst knowledge, cross-class communication networks, or agricultural information. Overall, greater access to information for women in PN-KB will likely lead to behavioral changes, thus increasing the possibility of protecting park resources. Additionally, in bolstering women's groups, a greater connection between the group and managers and between the group and residents could be fostered.

Language is also a communication barrier in PN-KB. While the majority of PN-KB residents identify as Kinh ethnic group, there are smaller ethnic minorities that also live in PN-KB, predominately in the core zone. Resident 18, a teacher in a remote and isolated core zone community, reported that many of his students speak a Van Kiều ethnic dialect and cannot communicate well with rangers who only speak Kinh dialect. Resident 18 also reported that this communication barrier results in sustained

deforestation within the core zone community because of a lack of understanding of forest and resource protection as communicated by the rangers (Resident 18, Commune 2, personal communication, 2017).

For isolated core zone communities, physical barriers to communication also exist. Resident 18 reported that the village he served did not have Internet or phone and, therefore, any communication into the community had to be done face-to-face (Resident 18, Commune 2, personal communication, 2017). While this may be positive at times, the physical path to this village is treacherous and is only passable during the dry season and haphazardly during the monsoon season. For rangers, whose main mode of transportation are small scooters, the mountainous roads are even difficult to ride during the dry season. Thus, communication into the core zone villages only occurs when absolutely necessary. This physical isolation, however, is not just confined to the core zone; Residents 21, 22, and 23 from Commune 3 lived in homes that were only accessible by crossing the Son River. Thus, during the monsoon season, these residents reported that they are unable to cross the river and access resources on the other side, including the main town and management headquarters (Resident 21, Commune 3, personal communication, 2017; Resident 22, Commune 3, personal communication, 2017; Resident 23, Commune 3, personal communication, 2017); yet, while some communities face language, resource, or physical barriers to communication, this represents only a small portion of the population. Most residents live within walking or driving distance from town, ranger stations, or the management offices that are readily accessible year-round. In these cases, the barriers to communication are simply the misplacement of information centers or the confinement of which residents have access to information and communication networks.

Overall, residents possess the largest social networks in PN-KB, but are also the group with the least access to consistent communication with upper-class citizens. Confirming the information pathway established by Hoang et al. (2006), the information passed to residents of PN-KB must go through many levels of social interaction, leaving the information stripped and simplistic once it arrives to the residents. The information may also be incorrect or misconstrued, as it has traveled through many social interactions before reaching its final destination. The communication pathways from the management board to the rangers, and then to the residents, are dominated by formal interactions, of which the audiences are confined to specific residents; therefore, the lack of informal communication between social classes and the lack of inclusion of lower classes in formal trainings creates a fragmented social network that is not conducive for the transfer of information and, therefore, the protection of PN-KB's vulnerable natural resources.

5.5.2 Information Access among Park Residents

While PN-KB residents may possess the largest and most diverse social networks, their access to outside scientific information is extremely minimal. As previously described, the group with the greatest access to information regarding PN-KB, its resources, and its landscape is the PN-KB management board. Interview data suggest that this information rarely, if ever, trickles down to residents, who most often are only told what they need to do to maintain legality and livelihoods within PN-KB; therefore, professional relationships between residents and either rangers or managers are required in order for residents to receive any scientific information. For example, interview data imply that residents serving in forest protection groups are more likely to learn scientific information about PN-KB's forest and biodiversity, because of their professional

relationships with park rangers (Resident 19, Commune 2, personal communication, 2017). Two residents working as teachers were more likely to learn information regarding PN-KB's natural landscape and tourism, because of their professional relationship with rangers who visit schools (Resident 18, Commune 2, personal communication, 2017; Resident 41, Communes 5, personal communication, 2017).

An additional avenue towards accessing scientific information is through media; however, the extent of information learned through media is limited. Eighty-four percent of interviewed residents understood what caves were and attributed this understanding to the commercials that they see on television that advertise tourism at local show caves (Table 5.3). While the majority of residents understood the term *cave*, only one interviewed resident correctly used and understood the term *karst*; no interviewed residents were able to identify karst processes, karst water resources, or the interconnectedness between karst landscapes and flora and fauna (Table 5.2; Table 5.3). This division of understanding is directly attributable to residents' information access; the majority of residents could only define the word *cave* because the extent of their incoming scientific information is indirect and from television whereas one higher-class, ex-government official could define *karst* because of his direct access to the internet via a personal computer and books (Resident 43, Commune 5, personal communication, 2017). Despite these divisions in access to information regarding karst landscapes, even the most educated resident interviewed as part of this research possessed only superficial understanding of karst landscapes and lacked comprehension of the surface and subsurface interaction of all karst resources including water, air, and soils.

Results from this study confirm the research of Hoang et al. (2006) and Khatam et al. (2013) in that access to correct and pertinent information is concentrated among privileged classes; moreover, lower class residents with less access to PN-KB policy or scientific information are less likely to change their own behaviors to protect PN-KB resources, because they are unaware of how the resources impact themselves and their livelihoods. For example, Resident 6 explains that he "does not have a lot of trees" and, therefore, he "has no reason to speak to the park rangers" (Resident 6, Commune 1, personal communication, 2017). Resident 35 also reflects this sentiment, stating that the park officials never speak to him, because he "just farms and they do not want to talk to him" (Resident 35, Commune 4, personal communication, 2017). These data suggest that rangers concentrate their communication to individuals with significant forested land, which, as observed, is not owned by common farmers.

With regard to agricultural information flowing from commune offices, interview data suggest that this communication flow is hindered and biased similar to that coming from park offices. This fragmented access to agricultural information between upper and lower class citizens was perfectly described by Resident 1, who stated that commune officials do not communicate with residents freely and choose only a few residents to whom they communicate (Resident 1, Commune 1, personal communication, 2017). Throughout all 50 interviews, when questioned about contact with commune officials, no resident identified having any such conversation, suggesting that the communication of agricultural information by commune officials does not occur frequently or only occurs with a select few residents.

Both the research of Hoang et al. (2006) in northern Vietnam and this case study in PN-KB show that communication of information to fewer, wealthier residents greatly inhibits the quick and unobstructed flow of this information to the broader population; therefore, both past research and this study suggest that to appropriately communicate information regarding policy, agriculture, or science, a broad base of citizens must be chosen to receive and further communicate this information. The general lack of communication between all individuals working and living within PN-KB inhibits existing information from permeating all communities. To foster more learning and communication of information within PN-KB, increased formal and informal communication must occur between park official, rangers, and residents. Based upon the current state of informal communication between park residents, data suggests that residents are very likely to approach neighbors to learn more information about successful agricultural techniques. Thus, strategies for informal communication between residents and villages can be informed by exploring how agricultural information is currently spread among farmers in PN-KB. These informal communication techniques and residents' willingness to learn will provide the foundation for recommendations on karst landscape education. These strategies are discussed in Section 5.7.2.

5.6 Challenges and Strengths in Agricultural Management in PN-KB National Park

Agricultural practices across PN-KB are largely uniform, and agricultural information is most commonly communicated between commune officials, heads of villages, and park residents (Figure 5.9). Commune governments often have control over the crops, fertilizers, and pesticides used in their jurisdictions. Each individual farmer, however, can determine when to plant crops, if and when to apply chemicals, and when

to harvest. Roughly half of the interviewed residents reported that planting and harvest schedules are discussed and determined at village meetings. Collected interview data revealed that common crops grown by PN-KB residents include corn, rice, cassava, guava, peppercorn, rubber trees, paper trees, and sweet potatoes. The majority of planting and harvesting occurs during the dry season of March to September. As it pertains to the knowledge of karst landscapes and successful communication techniques, understanding current agricultural practices and information transfer among residents is crucial.

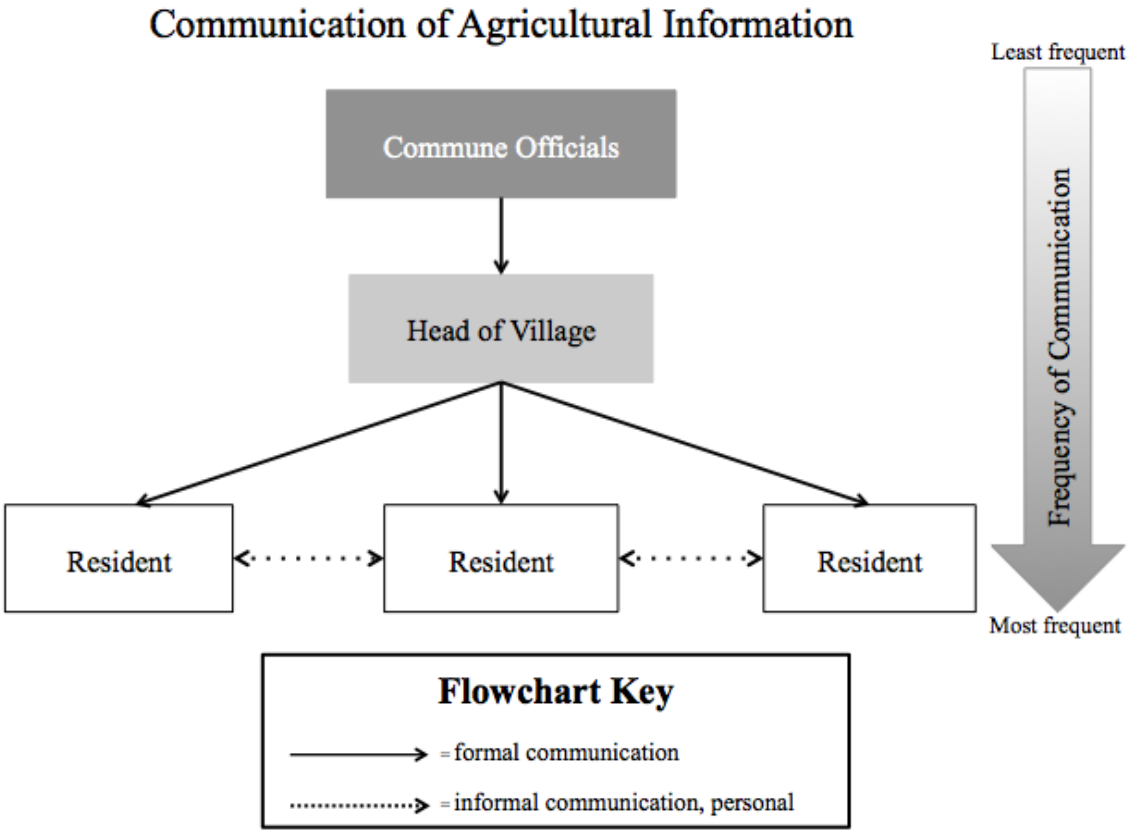


Figure 5.9: Communication of agricultural information to PN-KB Park Residents (Created by author).

The agricultural techniques used by farmers in PN-KB are on par with subsistence agriculture, but still harm PN-KB's vulnerable karst terrain; however, while it was

expected that significant intensification and irrigation would occur on the farms in PN-KB, this was not confirmed through interviews. Instead the researcher documented that farmers only used minimal artificial irrigation and their farms were not overplanted. Most farmers reported only one or two harvests per year. While approximately half of the interviewed farmers used only rainwater for farm irrigation, others used local ponds, rivers, or groundwater. Irrigation practices were never observed in the study area, but it was found that many homes had wells or rain barrels to collect water resources. Despite the moderate use of irrigation, its impact on land and water quality is likely negligible compared to the natural flooding that occurs in the study area.

Interviewees reported that the greatest issue on farms is a lack of water during the dry season and the overabundance of water during the wet season. Thus, farms become desiccated during the dry, growing season but then become saturated during wet season, resulting in the runoff of significant amounts of sediment into surface and subsurface waterways. While residents do not communicate with neighbors about dry season farming techniques, two residents noted that they were advised by neighbors to add soil onto their farms in order to elevate it from flooding (Resident 9, Commune 1, personal communication, 2017; Resident 10, Commune 1, personal communication, 2017).

Observational data from this study suggests majority of karst terrain degradation by farmers in PN-KB is caused by the use of fertilizers and pesticides and erosion-inducing crops, such as rubber and paper trees. While deforestation is also a cause of karst degradation and agricultural hardship, it was not readily observed in any of the villages. In fact, many villages reported having educational and work programs aimed at replanting native trees to reforest and protect the landscape from drought and flood. Karst

degradation can be attributed to the use of synthetic chemicals, which was reported by 80% of the interviewed residents. Use of chemicals, while increasing yield, may also runoff into surface or groundwater sources, resulting contamination or an overload of nutrients, both of which harm the health of humans and biodiversity (Drew 1983; Coxon 2011). Chemicals, such as artificial fertilizers, can desiccate already sensitive karst soils and eventually decrease soil fertility and increase soil erosion (Coxon 2011). Farming residents of PN-KB, however, likely do not know or understand these negative consequences; one third of interviewed residents reported that their farmland was either just "good enough" or lacked nutrients. Additionally, as reported by seven residents, fertilizer use are the most common topics spoken of when communicating with neighbors (Resident 19, Commune 2, personal communication, 2017; Resident 20, Commune 2, personal communication, 2017; Resident 29, Commune 3, personal communication, 2017; Resident 30, Commune 3, personal communication, 2017; Resident 42, Commune 5, personal communication, 2017; Resident 47, Commune 5, personal communication, 2017; Resident 49, Commune 5, personal communication, 2017).

In addition to fertilizer use, many residents plant and harvest crops that are highly degrading (Fox et al. 2014). Farmers in Communes 1 and 2 harvested rubber and paper trees, while farmers in Communes 3 and 5 planted rice. As aforementioned, rubber and paper trees require significant soil nutrients and, once harvested, leave soils desiccated and infertile, thus increasing erosion (Fox et al. 2014). Rice farms line the banks of the Son River. Rice crops require consistent denudation of water and thrive in the wet season (Bouman and Tuong 2001). While residents were not observed using artificial irrigation in rice paddies, all rice farmers in Commune 5 reported that they utilized fertilizer on

their rice crops. When applied to rice crops, these fertilizers have the potential to contaminate the water supplies underlying the land and threaten river biodiversity (Bambaradeniya and Amerasinghe 2003).

The continued cultivation of rice, paper trees, and rubber trees reveals a potential desire to overlook any current negative farmland circumstances in order to make a living and a profit. This crop use also reveals that it is likely that residents are unaware of the negative long-term impacts of the crops on their farmland and health. Over half of the interviewed residents rely on groundwater for everyday life, but none could describe the potential impacts of agriculture on their groundwater and none identified agricultural practices as a threat to the health of the natural landscape (Table 5.2). This sentiment is shared by rangers and officials, as well, with none of the interviewees labeling agriculture as a threat to the natural landscape, biodiversity, or forest of PN-KB (Table 5.2). This misunderstanding lies both in the unawareness of karst processes and the long-term consequences on agricultural development.

While there is a lack of information on, and dedication to, sustainable agricultural practices, the communication groundwork for information flow among residents is strong. Agriculture is a consistent topic among informal communication networks in all villages and communes where interviews occurred. Additionally, residents have a robust trust in the informal advice and recommendations of fellow farmers. For example, as previously mentioned, Resident 10 noted that when he struggled with floods destroying his crops, his neighbors told him to move soils to build up his farm and decrease flooding; he immediately yielded this advice and was confident to communicate it to the interviewers (Resident 10, Commune 1, personal communication, 2017). Resident 37 also

described how if his family grows a crop well, they will tell other families and neighbors how to also grow that crop (Resident 37, Commune 4, personal communication, 2017); therefore, informal communication with neighbors and trusted individuals is a consistent reservoir of information for farming advice. Thus, collected data suggest that a lack of understanding of protective farming techniques is not due to poor communication, but instead can be attributed to a general lack of knowledge and information influx on how crops impact the land on which they are grown and how to choose and harvest crops for a sustained, long-term, healthy yield.

On the other hand, interview data suggest residents have a general distrust of the formal ideas of government representatives. This is exemplified in Communes 4 and 5 wherein residents questioned the expertise and trustworthiness of commune and park officials working in the area. In fact, residents of Commune 4 were extremely wary of outside presences and obtaining interviews proved difficult; when questioned about agriculture, residents were quick to describe their close relationships with neighbors, but distanced themselves from the formal networks of commune officials. The distrust of commune officials in Commune 4 stemmed from non-agricultural issues such as bribery and corruption, but this lack of trust has ramifications when it comes to access of new or updated agricultural information (Resident 35, Commune 4, personal communication, 2017). Without a trusted, formal source of information, residents are more likely to yield the advice of informal sources.

Mistrust of formal sources also prevailed in Commune 5. Residents of Commune 5 mistrust park rangers because of their dedication to spreading incorrect information. Resident 47 described how park rangers attempted to formally educate park residents on

how and why to reforest their village and what trees should be planted; however, Resident 47 also described that rangers insisted that residents attempted to grow trees that residents knew would not be supported by local soils. In this case, residents mistrusted the formal information sources, because these sources overlooked the expertise of locals and insisted that residents obey incorrect advice (Commune 5, personal communication, 2017). Thus, residents are more likely to mistrust formal communication avenues when these avenues dismiss the circumstances of residents and insist on spreading information that is incongruent with the needs or knowledge of residents.

Residents, rangers, and officials also assume that the divide between the buffer zone and the core zone is absolute, with representatives of all three groups noting during interviews that agriculture or degrading behavior in the buffer zone is not an issue, because it is neither near to nor within the core zone. Resident 47 remarked that he was "far from the core zone," so he does not need to speak to rangers, because his farming actions do not influence the core zone (Resident 47, Commune 5, personal communication, 2017). Additionally, Ranger 7 described that agriculture in PN-KB is not a threat unless it is in the core zone, which he believed to not be a threatened because they patrol the border well (Ranger 7, Ranger Station 3, personal communication, 2017). It was observed, however, that the border between the core and buffer zone is unnoticeable at points, with no formal markings or fencing. Therefore, without a demarcated border and without a true and functional understanding of the karst subsurface, continued misinterpretation of the border between core and buffer zone will result in agricultural contamination and degradation of karst resources and biodiversity.

In summary, farming practices in PN-KB meet present needs for food and livelihoods, but the future sustainability of these practices is questionable. What is known, however, is that residents, rangers, and officials do not understand the impact of agriculture on karst landscapes at present. Continued promotion and use of fertilizers and pesticides, as well as the growth of degrading crops, such as rubber and paper trees, places landscape integrity, human health, and karst resources at risk. Thus, residents' current need for livelihoods places their future farms at risk and has unseen, but widespread effects on PN-KB's protected karst terrain. Data reveal there is a current need for an incursion of farming information that draws both on PN-KB resident expertise and updated research from outside PN-KB. In utilizing existing informal communication networks between residents, this information can and should be spread quickly and with maximum effect.

5.7 Recommendations for Future Management Practices in PN-KB National Park

Recommendations for future policy communication were made based upon interview and observation findings. Currently, the PN-KB management board experiences strengths, challenges, and opportunities when understanding, communicating, and protecting the complete natural and cultural landscape of PN-KB. To achieve utmost protection of natural resources, PN-KB does not need to generate extensive cultural or communicative changes; PN-KB employees and residents already possess highly efficient communication networks, the use of which can be shifted in order to achieve maximum resource protection.

Current challenges for PN-KB managers are the lack of cross-class communication networks, confined relationships between rangers and residents, narrow

understanding of karst resources, minimal incoming scientific information, and a sense of division among PN-KB communes. An initial challenge in the management of PN-KB is the park management policy itself, which lacks any specific regulation to protect karst resources. PN-KB currently contains the world's first and third largest caves and its karst landscape is responsible for a portion of its extraordinary flora and fauna. As a UNESCO World Heritage Site and protected area, a lack of regulation protecting karst terrain places the geologic, biologic, and geographic resources of PN-KB directly at risk of degradation and destruction. Without written policy to protect karst resources, any work towards education and communication will be lost. The current policy of PN-KB contains significant regulations protecting forest and biodiversity and these work extremely well; by adding karst resources into existing regulation, it is likely that PN-KB officials and rangers would achieve the utmost protection just as they have for the flora and fauna. The addition of such regulations can include regular water quality testing, monitoring of cave species, resources for cave discovery and mapping, extended forest and biodiversity protection into the buffer zone, and stricter regulation on tourism practices within caves. The researcher also recommends that tourism be encouraged as an educational tool and tours can be used to promote the protection of cave environment. The use of tourism as an educational tool is discussed in Section 5.7.1.

Some current regulations practiced by the PN-KB Management Board indirectly protect karst resources, such as regulations against deforestation and protection for core zone species. The management board should collaborate with commune governments to encourage the use of natural fertilizers such as ash or compost. Commune and park officials can also work to encourage safe agricultural techniques when growing

potentially degrading crops, such as paper trees and rubber trees, including the use of intercropping and cover cropping with plants that encourage soil moisture retention and the return of important nutrients to soils (Verheye 2010).

Additional challenges in PN-KB management include the current relationships and communication between groups of different social status. Cross-class communication is extremely rare and constrained. Data from this study suggest that officials are unlikely to speak to rangers, unless legally required by their job title; rangers are unlikely to speak to residents unless they have a scheduled training or meeting, even then only interacting with a select few residents. Additionally, the communication networks in which these cross-class interactions occur are typically ill fitting or incongruent with the cultural and communicative needs of the information recipient. This division between groups is also evident between communes. While residents are likely to informally communicate to others within their villages, they are unlikely to speak to others in different communes. All of these communication divisions between class, groups, and communes results in a hindered spread of information and fragmentation among groups that are supposed to be working towards a single end: protect the natural resources of PN-KB.

A final challenge to the successful management of PN-KB is the general lack of incoming scientific information and minimal understanding of the karst terrain and resources of PN-KB. Funding for, and execution of, scientific research within PN-KB is minimal and this leaves many crucial areas of information unknown; for example, water quality within PN-KB is rarely tested and, when samples are taken, the parameters are overly broad. Without consistent and detailed water samples, PN-KB managers are not able to create a complete picture of the quality of PN-KB's water resources and this

places human and biodiversity health at risk. Additionally, PN-KB is 60% karst terrain and is almost completely dependent on water and economic resources provided by the karst landscape; however, even among individuals who know about karst landscapes, which is roughly 10% of the interviewed population, their understanding is superficial and is directly linked to the cave systems, which represent only a small portion of a karst system. Without understanding of karst resources, the ability to fully protect these resources is diminished.

Despite significant management challenges in policy, communication, and science, the employees and residents living and working within PN-KB possess significant strengths that will allow for future protection of all PN-KB resources. The greatest strength in managing PN-KB is the all-around dedication to and protection of the PN-KB's forest and biodiversity. Protection of these resources is detailed heavily in the PN-KB's policy and execution of these regulations is done enthusiastically by officials and ranger staff alike. The engagement and education of park residents regarding forest and biodiversity creates a model upon which future education efforts can be based. While current educational efforts are confined to school groups and citizen groups, an expansion of educational program that draws on rangers' enthusiasm for forest protection has high potential to expand knowledge on karst resource protection among all park residents.

A crucial strength to be drawn upon for better park management is the willingness and openness among park officials, rangers, and residents to learn more about PN-KB and its karst resources. All officials and rangers, as well as a majority of park residents, reported wanting to learn more about PN-KB's unique landscape. Overall, the strengths contained within people living and working in PN-KB allow future changes that will

address current challenges in park management. Recommendations based on these strengths and challenges are proposed in order to increase comprehension and understanding of karst resources, increase visibility of degrading agricultural practices, supplement current safe agricultural practices, and offer a reformed, inclusive communication network through which these changes can be spread (Tables 5.4 and 5.5).

Table 5.4: Recommendations for the influx of karst science into Phong Nha-Kẻ Bàng National Park (Created by author).

Topic	Recommendation	Description
Influx of karst science	Appoint karst science expert.	Find an existing employee to research and understand karst science.
	Collaborate with neighboring karst protected areas.	Create collaborations with Hin Namno National Conservation Area, Hạ Long Bay National Park, Cúc Phương National Park, and Cát Bà National Park.
	Solicit national and international researchers to work in PN-KB.	Work the with Institute of Geological Science to increase the number of scientists doing karst geoscience in PN-KB.
	Map caves.	Create maps of the currently known caves.
	Research local hydrology.	Create hydrological maps of the area.
	Test water quality.	Consistently test water quality in multiple locations around PN-KB.

Table 5.5: Recommendations for communication and management in Phong Nha-Kẻ Bàng National Park (Created by author).

Topic	Recommendation	Description
Communication and management changes	Update PN-KB policy to include regulations for karst landscape protection.	Include regulations that protect cave biota, water quality, and soil quality. Should include regulations for agricultural practices.
	Communicate karst science at Park-wide meetings.	Have the PN-KB karst expert or a national or international karst scientists formally educate attendees on karst processes.
	Educate on communication techniques at Park-wide meetings.	Have an employee train meeting attendees on the successful use of formal and informal communication when working with Park residents.
	Expand groups invited to Park-wide meetings.	Groups attending park meetings should be: park officials, commune officials, provincial officials, park rangers, heads of villages, and park residents. Representatives of each group should represent varying levels seniority. Employ a translator at meetings to ensure any individual at the park that does not speak the dominant dialect is both included and understood.

Topic	Recommendation	Description
Communication and management changes	Introduce agriculture into Park-wide meetings.	Increase discussion on the influence of agriculture on the health of park resources. Encourage collaboration between commune governments and the management board to better regulate agriculture.
	Utilize formal communication to educate on science and communication techniques at Park-wide meetings.	Park meetings should use formal communication to educate on science or new policy information.
	Increase informal communication at Park-wide meetings	Informal communication through discussion groups should be used at park meetings.
	Collaborate with tourism industry to educate park residents.	Require all tourism agencies operating in PN-KB to one day a month when park residents can visit show caves for free.
	Rangers and officials attend more park-wide meetings.	Ensure that all village meetings are periodically attended by a park official or ranger.

	Open office hours at Management Board	Once a week, appoint two park officials to have open office hours where residents can come and ask questions, ask advice, or lodge a complaint.
	Buffer zone communities without ranger stations form protection groups.	Communities without ranger stations should create forest protection groups that work with ranger stations in nearby communes.

5.7.1 Recommendations for Research and Information Access

Before communication of information and protection of resources can occur, the PN-KB Management Board must obtain more information on karst landscapes and their resources. With this information, the management board must update current policy and its plan to protect karst resources. To achieve this, it is recommended that:

- **The PN-KB management board should appoint at least one employee that is solely responsible for researching and understanding karst processes**. This research should also include any current research on the karst terrain that dominates southeast Asia. Next, PN-KB managers should contact and exchange scientific information with nearby protected karst areas including the Hin Namno National Conservation Area in Laos, Hạ Long Bay National Park and World Heritage Site, Cúc Phương National Park, and Cát Bà National Park and World Heritage Site. Hin Namno borders the western edge of PN-KB and the remaining three parks are located in the northern region of Vietnam. A scientific and

research collaboration between these parks has the potential to spread pertinent information on general karst landscapes and resources, as well as best management practices utilized. This collaboration can also lead to a network of opportunities for national and international researchers to enter these parks and conduct research, resulting in increased access to and understanding of pertinent and up-to-date karst science and management.

- **Once fundamental karst science is flowing into the PN-KB Management Board, officials and rangers should log known cave locations and map these caves**. Knowing cave locations and orientations will allow for park managers to better understand the subsurface hydrology of PN-KB. With a better knowledge of PN-KB's karst hydrology, managers can generate a more thorough plan for testing and protecting the water resources of PN-KB. While hydrological mapping in karst regions can be expensive and include practices such as dye-tracing, the cost of these studies can be reduced or absolved through collaboration with local cavers and scientists, including those working Oxalis, at a nearby tourism agency, and through the encouragement and openness to the research of outside scientists.
- **Currently, PN-KB works with the Institute of Geological Sciences at the Vietnam Academy of Science; soliciting researchers from this Institute, as well as international collaborations, can allow for an influx of scientific researchers**. PN-KB contains the world's first and third largest in terms of volume caves, in addition to over 300 other known caves; the famous and extraordinary nature of PN-KB's karst features can be used to garner enthusiasm and commitment among international researchers for doing research in PN-KB.

The PN-KB Management Board should require any individual doing research in PN-KB to develop and execute a plan for sharing this information with park staff and residents. It is also recommended that the management board require at least one employee to accompany the researchers. When researchers and park representatives gather data together, not only is a bond forming, but communication is occurring and park representatives are being informally educated and trained on new scientific concepts. Additional criteria for allowing research in PN-KB should include a plan for one or more scientist to meet with management officials or attend a Park-wide meeting and offer a formal training on their research and its relation to PN-KB resources. Moreover, the management board should require all researchers to generate a document outlining their research, findings, and conclusions to be returned to PN-KB so that it can be kept for future education and research efforts. Throughout all of these networks, park staff will be better prepared to formally and informally communicate karst science to the entire PN-KB population. Overall, through the use of both formal and informal communication between researchers, the management board, and residents, a steady influx of new and pertinent karst science can be established.

- **Once information on karst landscapes is gathered and organized, karst landscape protection should be added into the existing management policy**. Regulated aspects of PN-KB's karst terrain should include water, soils, caves, and biodiversity. Implementation of karst landscape protection should be modeled after the current implementation strategies for forest and biodiversity protection. PN-KB contains two departments—head rangers and animal protection—that are

experts on PN-KB's forest and biodiversity and these are the areas most successfully managed. Thus, if the karst landscape is understood, studied, and protected in ways similar to the flora and fauna of PN-KB, comprehension of karst processes would increase and degradation would decrease significantly.

- **One way that communication of karst science to PN-KB residents can be increased is through the use of the existing tourism industry**. **Moreover, the tourism industry also needs to be held to higher standards of accountability to PN-KB management.** PN-KB currently sees thousands of tourists per day visiting PN-KB's show caves (Thanh 2012). The agencies operating tours to PN-KB's caves and springs are directly accountable to the PN-KB Management Board and must reapply for an operational permit every year; however, the management board currently demands minimal accountability from these agencies. While park residents and rangers are expected to abide by PN-KB policy, tourism agencies are often left to operate by their own established rules. To ensure complete protection of PN-KB's karst resources and utmost engagement of residents, the management board should hold tourism agencies to higher accountability and require agencies to offer free tours to residents.

Residents are highly aware of the booming tourism industry in P-KB, but only 22 of the 50 interviewed residents had visited any caves within PN-KB and only half of those residents had participated in a guided tour in a show cave. Twelve of the interviewed residents further expressed that they would better understand caves if they were given free passes to these cave tours. Residents reported that they could not afford cave tours. Therefore, tourism agencies must

be required to set aside one day every month where residents of PN-KB can access free cave tours. Engaging residents in cave tours would increase resident exposure to karst information. Research by North (2011) and Cigna and Forti (2013) describe that cave tours are an accessible way to informally educate large groups of people on the dynamics and uniqueness of caves and karst terrain. Therefore, in reference to the lack of understanding of karst landscapes by park residents, the cave tours operated within PN-KB are largely an untapped, convenient resource of karst education. By capitalizing on residents' willingness and excitement to learn about karst landscapes, tours that show the beauty and uniqueness of caves and their biota can create an informed public and instill in residents a pride in the karst terrain upon which they live. Therefore, just as residents are devoted to protecting the PN-KB's biodiversity and forest, cave tours can extend this devotion to understanding and protecting PN-KB's cave and karst resources.

- **In addition to the inclusion of karst information in policy, communication among the management board must be restructured. The use of formal meetings and trainings on karst landscapes should take place with all departments present.** The presentation of karst science should be interdisciplinary to show all aspects of karst landscapes, including the surface and subsurface processes, as well as their secondary effects on outside units such as humans, flora, and fauna. In utilizing formal communication methods, the communication of scientific and technical information will be highly structured, which can lead to increased comprehension of difficult topics. Results from this

project reveal that formal trainings are the most successful way of spreading policy and scientific information to large groups of people. Thus, an increase in formal communication and interaction between all PN-KB management units will also increase the likelihood of a unified commitment to karst protection.

- **The access to the PN-KB Management Board and rangers, as well as any educational material, needs to support any and all languages spoken within PN-KB.** At present, Park-wide meetings and educational materials offered by the management board are only available to individuals who speak the dominant Kinh dialect. Moreover, even in communes with minority populations that speak different languages, rangers are often only fluent in the Kinh dialect and, therefore, cannot effectively communicate or educate their constituency. As such, it is recommended that Park-wide meetings employ multiple translators who can transcribe and translate meeting topics into minority dialects. This will also allow village representatives who are not fluent in the Kinh dialect to attend and participate in Park-wide meetings. Additionally, educational resources created and dispersed by the management board and rangers, such as books, posters, pamphlets, and maps, should be made available in all languages spoken throughout the park. Altogether, by making park topics and park policy universally accessible to all residents in PN-KB, no matter their ethnic identity, will allow for greater inclusion and more successful resource protection.
- **Formal trainings among park officials, rangers, and heads of villages should also include information regarding communication techniques for formal, educational communication and the mechanics of informal communication.**

In the future, officials, rangers, and Heads of Villages can tailor their meetings' content and delivery based on the population with which they are working. For example, rangers should be trained to use informal and educational communication with age-appropriate resources when working with children. This change in content delivery will address the current challenges in cross-class communication. When coupled with the influx of scientific information, these trainings will help broaden the idea and mission of PN-KB to a much wider audience. Though incorporating the entire population on PN-KB with the mission of PN-KB, a greater understanding of and devotion to park resources will likely increase protection of those resources.

5.7.2 Recommendations for Management and Communication

A general increase in communication among all parties working and living within PN-KB is mandatory to achieve complete and sustainable protection of the forest, biodiversity, and karst landscape. To increase broad communication and involvement of all populations, specific changes among current management and communication practices must be addressed (Figure 5.10). To generate successful communication of information, a drastic cultural change in communication is not needed; instead, these recommendations will focus on small manipulations in existing communication networks. As previously discussed, informal communication among residents is an extremely effective tool in dispersing agricultural information; additionally, formal trainings between the managers and rangers are successful in educating rangers on policy and forest protection. Therefore, recommendations for future management and

communication tactics capitalize on these existing strengths in order to best spread information on PN-KB policy and natural resource protection.

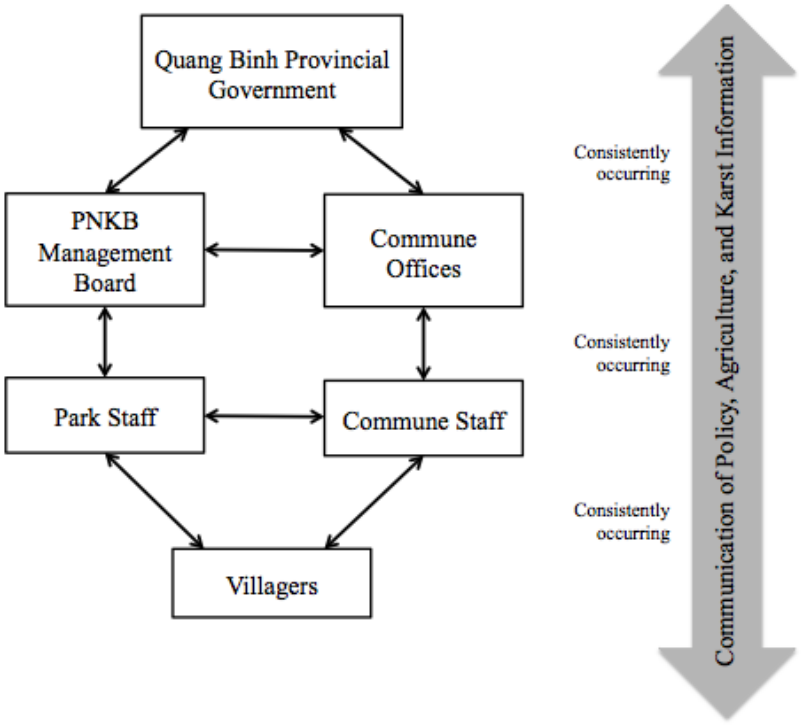


Figure 5.10: Ideal flow of information among all groups living and working within PN-KB. Methods of communication should be both formal and informal, as outlined in Figures 5.10 and 5.11 (Created by author).

- **Bi-annual, Park-wide meetings can be altered to increase cross-class communication and the inclusion of all park populations** (Figure 5.11). Currently, these meetings are confined to a small population of people, often representing only the highest ranked representatives within PN-KB and commune management. By increasing the size and audience make-up of these meetings, the information communicated is more likely to reach a larger population. For example, by communicating to both village representatives and heads of villages,

there will be double the likelihood of the information being spread amongst residents. In addition to larger meetings, the communication styles used during the meetings must be varied.

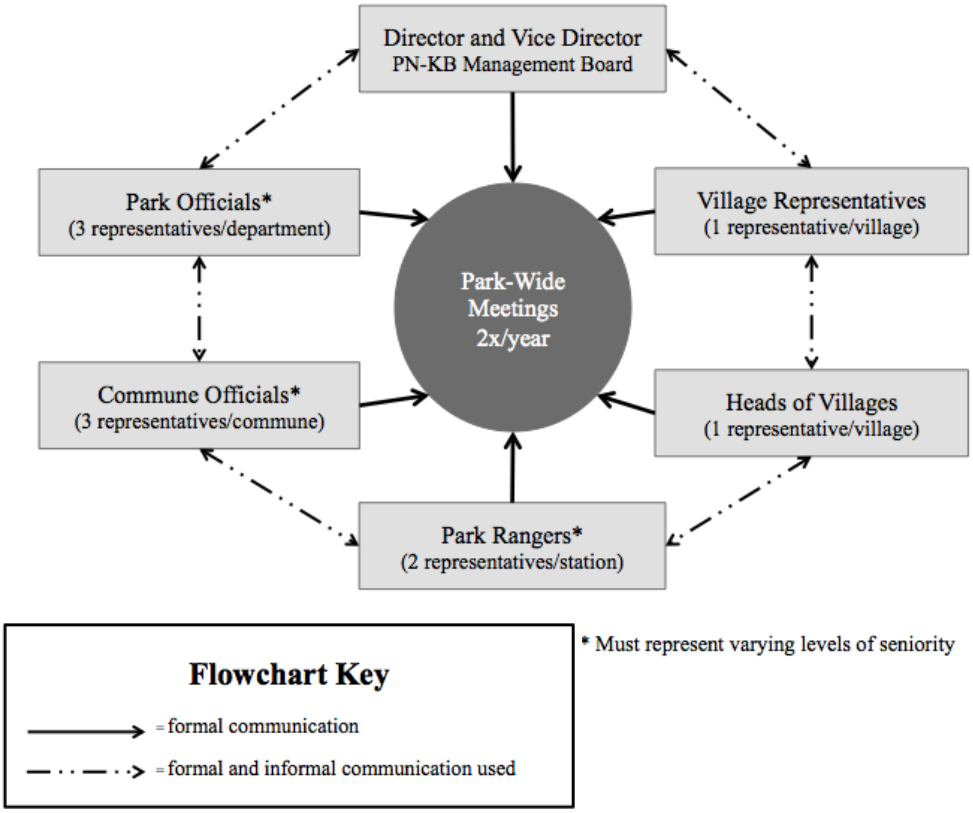


Figure 5.11: Ideal model for bi-annual Park-wide meetings (Created by author).

- **At Park-wide meetings, formal communication can be used to teach policy, scientific information, and communication techniques.** This formal education can be executed by whichever individual is doing the teaching; for example, if a karst geoscientist is instructing the meeting, he or she will utilize formal communication techniques to teach about karst landscapes and processes.

Representatives of each group can also use formal communication in order to update the entire meeting on their population.

- **The researcher recommends that each Park-wide meeting contain time for participants to divide into small groups to discuss policy and science updates.** Discussions utilize informal communication, which is proven through this and other studies to be the ideal way for learners to comprehend, process, and put into effect policy information (Sutton-Grier et al. 2016). Informal communication and discussion can also be used by teachers to assess if and how the learners are synthesizing the information (Sutton-Grier et al. 2016). Small-group and meeting-wide discussion can simultaneously be used to educate and assess educational tactics, in turn ensuring that future meetings capitalize on education that is tailored to the audience.
- **Park-wide meetings encourage collaboration between commune governments and the PN-KB Management Board on the topic of agriculture.** Currently, agricultural topics are rarely, if ever, communicated between commune governments and PN-KB officials and rangers; however, since agriculture can have a direct and dire effect on the natural landscape of PN-KB, it is imperative that communications between commune and PN-KB officials about this topic increase. This can be accomplished during the bi-annual meeting, where village representatives can speak on their agricultural needs and techniques and rangers can speak on the threats of agriculture to landscape protection. In generating a conversation on agriculture in which all stakeholders are present, compromises

and techniques for agricultural livelihoods can be established and implemented (Figure 5.12).

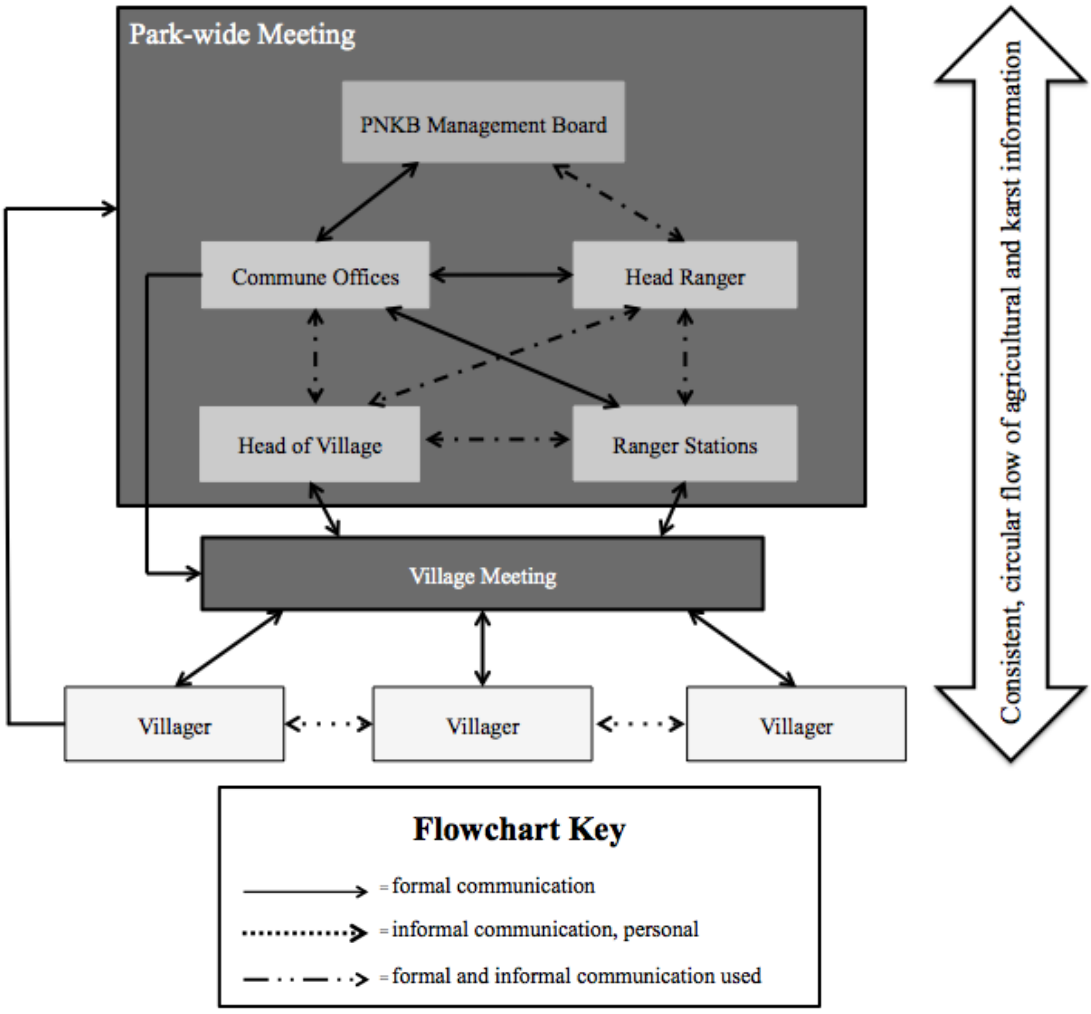


Figure 5.12: Ideal communication model for Phong Nha-Kẻ Bàng Phong Nha-Kẻ Bàng National Park officials, rangers, and residents (Created by author).

Outside of meetings, the researcher also recommends that there be an increase in points of communication and engagement between officials, residents, and rangers. Currently, there are significant physical and communicative barriers between these three groups. These barriers allow the three groups to remain separate from each other,

ushering in isolation and elitism and diminishing positive work towards achieving the mission of PN-KB. It is recommended that officials and rangers exhibit greater involvement in communities and that residents are allowed greater involvement in management activities. This can be achieved in a number of ways, such as park personnel at village meetings, increased ranger presence in outer buffer zone communes, and more avenues in which residents can communicate with park officials. As aforementioned, these recommendations for increasing communication work within already established communication networks; therefore, application of these recommendations can be more easily implemented and goals more easily achieved. The recommendations are:

- **To increase the visibility of park officials and rangers, the researcher recommends that the management board send park officials to village meetings** (Figure 5.13). This will not only break down the cultural and communicative barriers between park personnel and park residents, attendance at these meetings will also allow park personnel to become more aware of the issues that impact residents day-to-day. Additionally, PN-KB officials and rangers can also use village meetings to spread new information regarding science or policy. Communication techniques used during these meetings will be both formal and informal, using formal methods to teach information and using informal methods to encourage discussion and questions on the usefulness and importance of the information. Because agriculture is a common topic at village meeting, this is also an avenue for villagers to educate park personnel on their current agricultural techniques; through this discussion, compromises on techniques can be made that

encourage both environmental and karst landscape protection, as well as agricultural livelihoods.

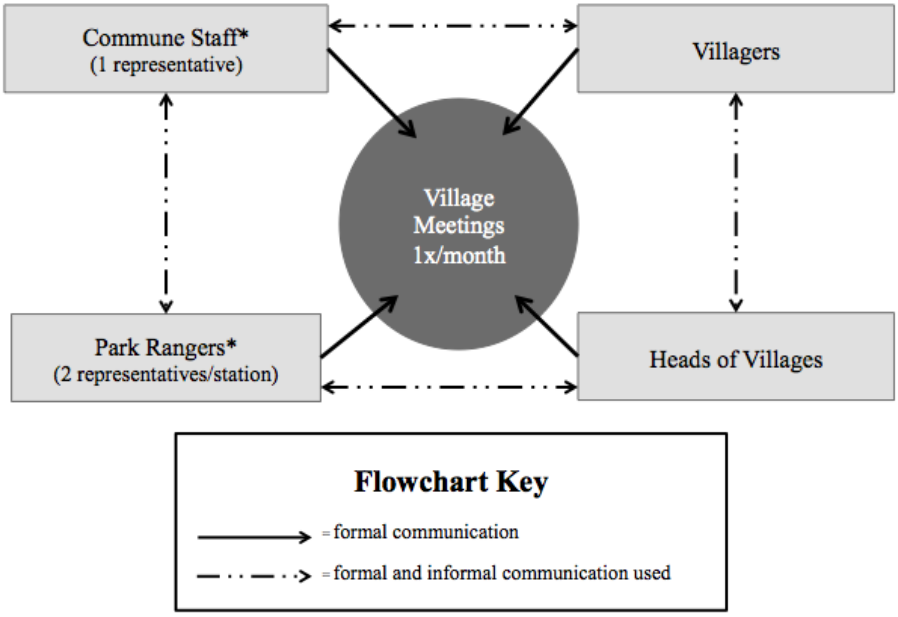


Figure 5.13: Ideal communication model for village meetings (Created by author).

- **Park rangers should become more engaged with buffer zone communities that lack ranger stations.** Placement of ranger stations is also an important aspect in the protection of PN-KB's resources. Currently, ranger stations are situated mostly on the border between the buffer and core zones; however, without rangers to regulate degrading behaviors in the buffer zone, degradation of PN-KB resources continues with little change. While building completely new ranger stations in the buffer zones is ideal, it is not likely to be economically achievable. Instead, the researcher recommends that in each buffer zone community without a ranger station, rangers periodically attend village meetings to educate and communicate to these villages about the mission and policy of PN-

KB. Additionally, buffer zone communities can also elect residents groups to aid rangers; just as communes with ranger stations have forest protection groups, so communes without ranger stations should be able to form these groups. Park rangers have difficult jobs with protecting natural resources and educating communities; by adding additional volunteers, rangers will be able to do their jobs more effectively and an increase in informal communication regarding park resources will also occur.

- **Residents should be offered more opportunities to become involved with the management of PN-KB.** While it would be ideal to create an entirely new human resources department within the PN-KB management board, this is likely not economically feasible; therefore, utilizing the current resources and personnel working for the management board, increased communication between residents and officials can be achieved through two mechanisms. First, **villages can hold small-scale elections that designate village representatives to attend management meetings and represent the needs of each unique village**. These representatives will be different than village heads. Second, the management board can **implement open office hours once a week where a panel of management representatives is present to hear and address any comments, complaints, or needs from residents**. In implementing these two strategies, utilizing both formal and informal communication, the connection between officials and residents will flow in two directions. Encouragement for villagers to feel engaged and important in the management of PN-KB will likely increase

their allegiance to the park mission and, therefore, grow the potential for greater protection of the PN-KB's natural resources.

At the core of all recommendations listed here is the utilization of both formal and informal communication techniques. Based on this study, formal communication can and should be used to introduce hard-to-learn concepts, new scientific information, and functional tools for interpersonal communication. Through classroom or training-like sessions, this hard information can be learned and adapted for each unique situation in which it is used. Additionally, informal communication can and should be used to spread pertinent information very far and very quickly. In nearly all policy- or science-related interactions between officials, rangers, and residents, the bulk to PN-KB's social network—common citizens and, especially, women—are left out of the conversation. Instead, policy and science becomes a topic isolated to only the highest social class members of the PN-KB population. Common citizens, including women, however, make up the largest population that has an impact on the karst landscape of the PN-KB; without efficient and consistent communication to these populations, the extent to which PN-KB policy will be effective is minimal, at best. Thus, through the utilization of informal networks among friends, family, and neighbors, important information can be delivered it to every corner of a social network, regardless of gender, profession, or class. By introducing these concepts of formal and informal communication into the day-to-day functioning of the PN-KB management board, information regarding policy, landscape protection, and agricultural techniques can spread more evenly among groups living and working in PN-KB. When these concepts are received through trustworthy networks,

residents will be more likely to alter their behaviors, thus expanding PN-KB resource protection among larger, more willing and knowledgeable populations.

CHAPTER 6: CONCLUSION

With Phong Nha-Kẻ Bàng National Park (PN-KB), Vietnam as a case study site, this research proposes that both formal and informal communication networks should be used to spread policy information and karst science in order for better protection of vulnerable karst landscapes. In particular, this study focused on the formal and informal communication networks that dominate agriculture-based communities. Minimal, if any, research has been conducted on the use of diverse communication networks in agricultural communities to foster the spread of karst science and to better implement policies to protect karst landscapes. No research has been conducted on these issues in PN-KB. Methods for this study included interviews, observation, and GPS locations. Interviews took place with park management officials, park rangers, and park residents, as these are the three dominant groups exchanging policy information in PN-KB. Interview participants were chosen in collaboration with personnel at the Institute of Geological Sciences at the Vietnam Academy of Science and members of the PN-KB management board.

Data for this project included 68 in-depth interviews, observations at every interview location, and GPS locations of each interview location, ranger station, commune office, and management board office. Resident interviews were conducted with both men and women of varying ages and professions. While Kinh was the only ethnic group represented among interviewees, accessibility to ethnic minorities located in the PN-KB's core zone was diminished due to unforeseen circumstances and these interviews had to be cancelled. Rangers that were interviewed represented five different ranger stations located throughout four buffer zone communes. Interviews with

management officials were representative of the management board and contained representatives from six units. Ranger and resident interviewees were all male and were representative of their broader populations in that no females were identified working as either rangers or residents. Altogether, the diversity of interview participants appropriately represents the working and residential park populations. Interview and observational data were transcribed and coded using content analysis methods. Additional analysis was completed using a Methods of Agreement model, in which interviews and observations were studied and dominant trends were identified. GPS points were downloaded into ArcGIS and maps were generated and used to visually analyze PN-KB population, commune location, and the locations of ranger stations relative to their assigned constituencies.

The results and recommendations outlined in previous sections of this document are founded upon the varying strengths and challenges observed within the staff and population of PN-KB. Park residents already possess efficient informal communication networks, but their on-the-ground agricultural practices need updating; conversely, officials and rangers have thorough information and dedication to PN-KB's forest and biodiversity, but lack comprehension of karst vulnerabilities and do not utilize all available formal and informal communication networks. The researcher recommends that additional connections must be made between officials, rangers, and residents and greater access to outside information and scientific research should also occur.

Currently, worldwide, there exists a general misunderstanding and under-protection of karst resources (North, 2011). Altered communication patterns and creative solutions to information access are both ways that PN-KB can become a world leader in

the education and protection of karst terrains. The key to successful protection of karst terrains is the communication of information that is both relevant and understandable to a broad population. For residents, rangers, and officials in PN-KB, information about karst landscapes must be relatable to their everyday lives. Whether it is farming, forest protection, or policymaking, karst science must be introduced in a way that is simple and accessible. For example, residents do not need to know the in-depth chemical processes influencing karst water quality and the communication of such information would be overwhelming, effectively shutting down the understanding and future communication of this topic; however, in simplifying the topic to outline the risk of water contamination from human and animal waste or agriculture would make this information understandable and accessible to all PN-KB residents.

In asking park residents and employees to change their behaviors for the betterment of karst protection, proposed actions should be simple and achievable. This can be completed through encouraging the use of natural fertilizers or intercropping for residents, or through the implementation of monthly water quality tests for rangers and officials. Small, gradual acts are less daunting, more cost effective, and set a standard for future increases in protective behaviors. Lastly, the introduction of new information regarding karst landscapes should be interesting and exciting. Nearly all interviewed residents were proud of their homeland's famous caves, setting precedent for future education that builds on this excitement and uses PN-KB's real-life landscape as an educational tool. When residents, rangers, and officials better understand their personal relationship with the karst landscape on which they live, they will be more likely to protect this land.

The spread of karst science and information must utilize existing networks of formal and informal communication within PN-KB. The simplicity of needed changes is more likely to lead to the consistent use of the changes. Successful use of the networks is displayed in the widespread understanding of forest protection and the way in which this understanding has led to highly successful protection of the forest. Whereas formal networks are used to communicate laws and science related to PN-KB's forest, informal networks are used to communicate this information to the entire park population. Thus, to increase education and understanding of karst landscapes, as well as the protection of these resources, proper use of formal and informal communication networks must be implemented. Through existing formal venues, such as Park-wide or village meetings, increased communication of karst science will lead to a greater understanding of how and why karst resources should be protected; through existing informal communication networks, the spread of karst science in a simple, meaningful way will result in widespread acknowledgement and protection of karst resources. Lastly, informal communication networks must contain all groups living and working within PN-KB. When all people in PN-KB, no matter profession, gender, or income, have a voice and stake in the protection of karst resources, the likelihood of protective measures being practiced will increase. In making local populations part of a solution, as opposed to separate from a solution, PN-KB management can effectively make each resident a steward of protection for PN-KB's unique karst, forest, and biodiversity resources. It is within this collaboration that landscape protection will thrive.

The use of informal communication networks to encourage the preservation and protection of karst landscapes is increasingly important throughout the world. Globally, a

growing population and expanding agricultural need has forced humans to live in close contact with karst landscapes (Coxon 2011). At the same time, there is a gap between karst scientists, policymakers, and the general population (Watson et al. 1997). For lawmakers and world citizens, they cannot protect karst resources that they do not understand; therefore, to bridge this gap and encourage karst landscape protection, scientists must be encouraged to communicate their findings in simple, accessible ways. Furthermore, citizens must be encouraged to take active roles in the communication of karst science and policy. Through formal workshops and informal communication, karst science can be made relatable and protective behaviors can be made simple, manageable, and incremental. Collaboration between scientists, policymakers, and citizens will create a network of accountability and communication, thus increasing the broad understanding of karst landscape vulnerabilities and subsequent protection. The interactions between humans, agriculture, and karst landscapes are inevitable but the nature of these interactions is open to positive change. By incorporating informal communication into current techniques for karst land management, future protection of karst landscapes will be an accessible option for all individuals working and living on these landscapes.

Throughout the world, protection of landscapes is largely dependent on the engagement of local populations. Both in PN-KB and abroad, however, local populations and their social capital are largely overlooked. At its very core, protection of natural resources relies on an educated, informed, and enthusiastic population. This study revealed that education and inclusion of local populations in landscape protection is impossible when communication networks between locals and land managers do not exist; thus, communication networks between diverse parties are key to educating and

enabling a responsible constituency. Without communication, links between populations lapse and education has no networks through which to travel; thus, information and policy remains among policymakers and constituencies are largely left out of the conversation. Through this study in PN-KB, data has largely suggested that by simply bridging communication gaps between all individuals living and working within PN-KB, education and policy information will begin to flow throughout all social classes. Cross-class, inclusive social networks between park management, park rangers, and residents will create an atmosphere in which all individuals in PN-KB are vehicles for policy application. At present, the protection of forests, biodiversity, and karst landscapes in PN-KB is extremely difficult with the management board's small staff; however, when all officials, rangers, and residents are equipped with pertinent and understandable information on park resources and policy, the amount of people protecting the resources in Phong Nha-Kẻ Bàng National Park will increase from a few hundred park employees to all 65,000 park residents.

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APPENDIX A

Semi-Structured Interview Questions		
Park Officials (6 Interviews)	**Park Rangers (12 Interviews)**	**Park Residents (50 Interviews)**
1. Talk about the landscape of the park. • Where did you learn this information? 2. Do you think that the land within the park's core area and buffer zone are well protected against negative human or agricultural influences? Why? 3. How often do you have contact with community members living in the Buffer Zone through your official work duties? • Do you ever communicate with community members? 4. How would you describe your communication with other park employees? • Do you talk about agricultural practices? Illegal activities like logging or grazing? Park management? • Through what means do you communicate most? Email? Face-to-Face? Phone? Etc. 5. How would you describe your communication with Park residents? • Do you talk about agricultural practices? Illegal activities like logging or grazing? Park management? • Through what means do you	1. Tell me about your role at the Phong Nha-Kẻ Bàng National Park. • What does a day at work look like to you? 2. What is the most difficult part of your job? • What do you enjoy most about your job? 3. Have you heard of karst landscapes before? Can you define it? • If so, how did you learn about karst landscapes? 4. What kind of training did you receive as a ranger? 5. What areas within the park do you serve? • How often are you in contact with: Park officials? Other rangers? Communities in Buffer Zone? 6. When speaking with a community member or group, what do you most often communicate about? Describe how this communication goes. 7. What kind of comments do you receive form park officials? Buffer zone	1. How long have you lived in this community? 2. What is your typical day like? 3. How do you earn a living? 4. If you farm: a. Do you find your land easy to farm on? Why? b. Do you have a larger land area before the area became a protected area? Why? 5. Do you know what a karst landscape is? a. If so, how did you learn about them? 6. Do you have any knowledge or information about the land you farm on? How did you learn about it? a. Did park officials ever give you information about your land? 7. How often do you communicate with other community members? a. How often do you communicate with park rangers? b. Park officials? 8. Who do you communicate with most

communicate most? Face-to-Face? Phone? Etc. 6. Do you often receive comments from park rangers and/or communities about park policies and park land? 7. What kind of comments do you receive from park rangers and/or communities regarding park policies? What feedback do you receive about land quality? 8. Do you think policy of PN-KB is well-enforced and practiced throughout the park? • Why or why not? • If no, what areas for improvement may exist? 9. When managing PN-KB, what do you think is the biggest challenge? What do you think is your greatest success? • When communicating to rangers and community members, what do you think is the greatest challenge? Success? 10. What do you think needs to be added to the Park's normal management regime? What do you think could be eliminated? 11. What do you see as PN-KB National Park's largest success? Largest challenge?	communities? 8. Do you prefer working with the natural resources of the park or with the park communities? Why? 9. What is your relationship with the park residents like? Do you get along well? Why?	frequently in your community? • Talk about how this communication goes. What sort of topics do you talk about? 9. Describe a typical communication between yourself and park rangers. 10. What is one way you think that communication among park groups could be improved? Why? 11. Demographics • Age • Ethnic Group • Family Members • Primary mode of income • Birthplace • Income/Socio-economic status

APPENDIX B

Resident Interviewees Demographics

Participant	Gender	Age	Ethnic Group	Occupation
1	F	46	Kinh	Sells fertilizer~
2	M	28	Kinh	Farmer
3	M	52	Kinh	Farmer*
4	M	56	Kinh	Farmer
5	M	57	Kinh	Farmer*
6	M	48	Kinh	Sells Rubber Products
7	M	60	Kinh	Farmer
8	M	56	Kinh	Farmer
9	F	56	Kinh	Farmer
10	M	45	Kinh	Farmer
11	M	34	Kinh	Sells phones
12	F	55	Kinh	Farmer
13	F	30	Kinh	Farmer
14	F	41	Kinh	Farmer
15	F	59	Kinh	Farmer**
16	F	60	Kinh	Farmer
17	M	71	Kinh	Farmer
18	M	49	Kinh	Teacher
19	M	51	Kinh	Farmer#
20	M	40	Kinh	Builds roads~
21	F	45	Kinh	Farmer
22	M	49	Kinh	Farmer
23	M	19	Kinh	Student
24	F	57	Kinh	Farmer*
25	F	40	Kinh	Sells groceries#
26	F	51	Kinh	Farmer
27	M	67	Kinh	Farmer
28	F	25	Kinh	Nurse
29	F	29	Kinh	Farmer
30	F	50	Kinh	Farmer

31	F	31	Kinh	Farmer
32	F	38	Kinh	Childcare
33	M	61	Kinh	Farmer*
34	F	26	Kinh	Farmer
35	M	35	Kinh	Farmer
36	F	28	Kinh	Sells Pharmacy~
37	M	40	Kinh	Brick maker~
38	M	67	Kinh	Farmer
39	F	37	Kinh	Farmer
40	M	25	Kinh	Farmer
41	M	28	Kinh	Teacher
42	M	55	Kinh	Farmer
43	M	60	Kinh	Retired, farms
44	M	45	Kinh	Farmer
45	M	49	Kinh	Farmer
46	M	48	Kinh	Farmer
47	M	59	Kinh	Head of Village*
48	F	38	Kinh	Sells groceries~
49	M	53	Kinh	Farmer
50	M	26	Kinh	Construction
* Denotes Head of Village				
**Denotes Vice Head of Village				
~ Farms, but not main job				
# Denotes member of forest protection or women’s group				

APPENDIX C

Interviewee Monikers

Interviewee	Role	Location
Management Official 1	Official with Head Rangers	PN-KB Management Board
Management Official 2	Official with Animal Protection	
Management Official 3	Official with Science and Research	
Management Official 4	Ranking official, overall management	
Management Official 5	Official with Finance Department	
Management Official 6	Official with Science and Research	
Ranger 1	Park Ranger	Ranger Station 1
Ranger 2	Park Ranger	
Ranger 3	Park Ranger	
Ranger 4	Park Ranger	
Ranger 5	Park Ranger	Ranger Station 2
Ranger 6	Park Ranger	
Ranger 7	Park Ranger	Ranger Station 3
Ranger 8	Park Ranger	
Ranger 9	Park Ranger	Ranger Station 4
Ranger 10	Park Ranger	
Ranger 11	Park Ranger	Ranger Station 5
Ranger 12	Park Ranger	
Resident 1	Sells fertilizer~	Commune 1
Resident 2	Farmer	
Resident 3	Farmer*	
Resident4	Farmer	
Resident 5	Farmer*	
Resident 6	Sells Rubber Products	
Resident 7	Farmer	
Resident 8	Farmer	
Resident 9	Farmer	
Resident 10	Farmer	
Resident 11	Sells phones	Commune 2
Resident 12	Farmer	

Resident 13	Farmer	
Resident 14	Farmer	
Resident 15	Farmer**	
Resident 16	Farmer	
Resident 17	Farmer	
Resident 18	Teacher	
Resident 19	Farmer#	
Resident 20	Builds roads~	
Resident 21	Farmer	Commune 3
Resident 22	Farmer	
Resident 23	Student	
Resident 24	Farmer*	
Resident 25	Sells groceries#	
Resident 26	Farmer	
Resident 27	Farmer	
Resident 28	Nurse	
Resident 29	Farmer	
Resident 30	Farmer	
Resident 31	Farmer	Commune 4
Resident 32	Childcare	
Resident 33	Farmer	
Resident 34	Farmer	
Resident 35	Farmer	
Resident 36	Sells Pharmacy	
Resident 37	Brick maker	
Resident 38	Farmer	
Resident 39	Farmer	
Resident 40	Farmer	
Resident 41	Teacher	Commune 5
Resident 42	Farmer	
Resident 43	Retired, farms	
Resident 44	Farmer	
Resident 45	Farmer	
Resident 46	Farmer	
Resident 47	Head of Village	
Resident 48	Sells groceries	
Resident 49	Farmer	
Resident 50	Construction	

Appendix D

Coded Rangers Interview Analysis

Below are selected codes derived from interview content and used for interview analysis. The codes represented below are the interpretation of the interview content by the author of this study.

Ranger Themes and Sub-Themes	Station 1 (R1-4)	Station 2 (R5, 6)	Station 3 (R7, 8)	Station 4 (R9, 10)	Station 5 (R11, 12)	TOTAL
Job Duties						
……fire protection	2	1		4		7
……forest protection	5	3	2	7	3	20
……karst protection (only caves)	1		2			3
……educate the commune	1	4	1	1	1	8
……animal protection	1			3		4
Topics of Education			1			
……animals	1			1	1	3
……forest and fire protection	1	2	3	3	3	12
……karst			2			2
……law	1	1			1	3
Barriers to communication						
……distance	2					2
……language	1			2		3
……religion		1				1
……time and money	1	1				2
……ethnic group	1					1
……don't understand each other		2				2
……weather		1		1		2
Border vs. Core Zone	2	1	1	1	2	7
Karst Knowledge						
……caves		3	1	1		5
……geology and geomorphology			2			2

……farming/human interactions	1					1
……forest and biodiversity						0
General Park Protection						
…… good	3		2	2	1	8
…… bad				1		1
Communication Locations						
……school	1	2	1		1	5
……groups	3			4	1	8
……village meetings	2	1	2		1	6
……commune office						0
……Head of Village	1		1		2	4
Communication with rangers and officials						
……officials			2		4	6
……rangers			1		1	2
……face to Face			3	2		5
……email		2		1	1	4
……phone		1		2		3
Is agriculture a threat?						
……Yes		3		1		4
……No	1		2		1	4
Relationship with residents, Officials, Rangers						
……good with residents	1	1	2	1	1	6
……bad with residents						0
……good with PO						0
……bad with PO						0
……good with Rangers						0
……bad with Rangers						0
Materials for education						
……books		1				1
……posters/maps/brochures		1				1
……no materials, just talk				1		1

Is karst impacted?						
……yes, natural		1	1			2
……yes, humans	1	1	1			3
……yes, tourists						0
……no	2		1			3
Ranger training						
……forest, biodiversity	2	3	2	2	1	10
……karst, caves	2					2
……karst, more than caves	1					1
……defense	2	2		1	1	6
……communication		2	2	1		5

APPENDIX E

Coded Park Officials Interview Analysis

Below are selected codes derived from interview content and used for interview analysis. The codes represented below are the interpretation of the interview content by the author of this study.

Park Officials Themes and Sub-Themes	**MGMT 1**	**MGMT 2**	**MGMT 3-6**	**Total**
Communication to…				
……government		2	2	4
……other Officials	2	6	1	9
……rangers	2	8	1	11
……residents	5	4	3	12
Topic of Communication				
……laws	2		2	4
……forest and fire Protection	5	8	3	16
……biodiversity	1	5	1	7
……karst	2	2	1	5
Barriers to communication				
……no barriers				0
……language	1	2		3
……ethnic groups	2	1		3
……Distance		1		1
……Technology	2			2
……not enough communication between rangers, park officials, commune officials	3			3
……cannot offer anything to the population [jobs]			2	2
Border vs. Core Zone	3		1	4
Karst Knowledge				
……caves	6	5	2	13
……geology and geomorphology	4	1	6	11
……farming/Human interactions		1		1

……forest and biodiversity		2	4	6
……Karst Water	8	1	3	12
General Park Protection				
……good	7	4	1	12
…… bad				0
Communication Locations				
……no communication				0
……office				0
……park-wide meetings		5	1	6
……commune office				0
……in village, village meetings	3	2	1	6
Communication with other Rangers, Officials				
……face to face	2			2
……phone	2			2
……email	1			1
Is agriculture a threat?				
……Yes			1	1
……No	2	1	1	4
Rx with residents				
……good with residents	2			2
……bad with residents				0
How did MGMT learn info?				
……trained		2	2	4
……given by government	1	2		3
……German/British Scientists	1	4	1	6
……university	2	1		3
Agriculture - what is communicated?				
……how to grow	4		2	6
……what to grow	3		1	4
……agriculture and park protection			1	1
……agriculture and karst	1			1

Community Education	6	3		9
Problems in the Park				
……agriculture	1	1	6	8
……illegal activity	3			3
……water	6	1	1	8
……breaking formations	1		2	3

APPENDIX F

Coded Residents Interview Analysis

Below are selected codes derived from interview content and used for interview analysis. The codes represented below are the interpretation of the interview content by the author of this study.

Resident Themes and Sub-Themes	**Commune 1**	**Commune 2**	**Commune 3**	**Commune 4**	**Commune 5**	**Total**
Land Tenure						
……long	10	9	10	9	9	47
……short		1		1	1	3
……marriage		1		1	1	3
……economic development	8					8
……better land	2					2
Farming Easy	10	6	6	7	6	35
Farming Difficult		2		1		3
Use fertilizers and Pesticides	10	7	7	9	7	
Problems with Farm						
……floods	5	3	7	7	7	29
……not enough water	7	7	5	5	3	27
……nutrients		1		2	3	6
…….rocky				1		1
……animals					1	1
……money	1					1
Karst Knowledge						
……don't Know			1	4	4	9
……caves	7	6	9	5	6	33
……geology and geomorphology	1	1	1	2	2	7
……water						0
……tourism value	3	2	1		1	11

……from TV	8	10	7	4	9	38
……visited caves	7	3	4	5	8	27
……biodiversity	1					1
Communication with fellow residents						
……none	1	1	1		1	4
……life	9	8	7	7	8	39
……farm	10	8	5	6	6	35
……karst		2	1		3	6
……job	1	1		1		3
Communication with rangers						
……forest/fire protection	6	4	1	1	3	15
……karst		1				1
……law		1				1
……friends	4	1	1	3	1	10
……Farm	2					2
……job	2	2		1	2	7
……never	1	7	6	6	5	25
Communication with park officers						
……friends	1	2			1	4
……never	3	6	8	8	5	30
……farm	1					1
……chance encounter through job		1	2	1	1	5
……karst			1			1
Want to communicate with Rang/PO?						
……no	3	5	5	7	5	25
……yes - to report				3	1	4
……yes - farming	4	1	1			6
……yes - karst		2	6	2	1	11
……yes - jobs			1		1	2
……yes - to better protect	2	3		2		7
……phone	2					2
……face to face	3		1			4
……email						0
……want entry to caves for residents	1	2	1	4	4	12

Communication with commune officials						
……never	1	6	1	3		11
……as needed - to report	1	2	6	5	6	20
……documents		2				2
……farm	2			1		3
……friends	3	1	2	1	1	8
……training	1		1	1	1	4
……environment/forest	2	1				3
……caves/tourism			1			1
Communication with Head of Village						
……forest/fire protection	3				2	5
……farm - what to plant	3	3		6	4	16
……farm - when to do stuff	1	1		3	4	9
……farm - fertilizers and chemicals	1		1	2	2	6
……karst				1	1	2
……plan of village/security	1	1	1	8	4	15
Water source						
……groundwater	9		9	10	9	37
……surface water	3	5	4	2	6	20
……manufacturer		6				6
……Rain	3	5	3	5	1	17
Tourism						
……communicate with guides		1	2	2	1	6
……causes damage		2		1		3
……good for park		2			2	4