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The elephant groups of East Kalimantan



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Introduction

The Asian elephant lives on the island of Borneo only in the south-eastern part of Sabah and the northernmost part of East Kalimantan. Its origins are still not completely known but it is sure that the Borneo elephant is a distinct sub-species found nowhere else.

The elephants of East Kalimantan have only attracted more attention since about two decades ago, even though their presence here has been known for more than 100 years. More detailed investigations on the elephants and their habitat use were started only some 10 years ago.

One of the major findings during the latest elephant surveys in East Kalimantan (Wulffraat, 2007) was that a distinction has to be made between areas or habitats that are used by elephant herds, and areas that are used only by solitary elephants.

This current report deals mainly with the elephants and elephant habitats in the north. These are the main locations where elephant herds are known to roam. The management of these habitats has become a major conservation priority following the designation of the area for economic development.

Most of the northern habitats are currently part of the logging concession of the timber company PT Adimitra Lestari that started their logging operations at the beginning of 2008. WWF is developing a collaboration framework, and the company has expressed their commitment to ensure that logging operations will not disturb the elephants.

Logging temporarily disturbs the elephants, particularly when operations are taking place in areas that coincide with the movements of elephant herds. However, long-term disturbance to elephant populations can be relatively low. Elephants can thrive well in forests that are being logged as long as their most important habitats and routes are set aside. Logging can therefore be compatible with elephant conservation if practiced properly.

This report describes the population of elephant groups and their major and minor habitat utilization. This consequently deals with the food plants and salt licks and thus the elephant routes and the corridors

The overall goal of this report is to provide all necessary information and basic recommendations needed to develop a comprehensive management plan for the elephants and their habitats.

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The species

The first records of elephants in the northern part of Kalimantan are from the 19th century. It was generally assumed that the elephants in Borneo were introduced and later released into the wild, and are thus a feral stock, not really native to Borneo. Then in 2003 it was found through DNA analysis (Fernando *et al*, 2003) that the elephants in Borneo are of a sub-species different from any of the other known sub-species of Asian elephant. This led to the conclusion that elephants are in fact native to Borneo. It could however never be explained why the range of the elephants is so restricted to a small area in north-east Borneo.

The latest theory (Cranbrook, Earl of, Payne, J. & Leh, C.M.U., 2008) suggests that the elephants in Borneo are originally from a population of an elephant sub-species native to Java. They might have been caught in the wild in Java and then via Sulu (south Philippines) introduced to north-eastern Borneo. A study of historical reports on elephants in Kalimantan virtually confirmed that elephants never made it further to the south and west of the Sebuk area, which strengthens the idea that elephants were indeed introduced. No proof however could be found that there was still a population of wild elephants in Java by the time that elephants could have been transported to Sulu.

An overview of all information on the origins of the elephants of Borneo is available in the appendix.

Whether the latest theory is right or wrong, the fact remains that the Borneo elephant is a separate sub-species unique to the island of Borneo. This fact and the small and threatened population still imply that management of the elephant habitats is a very high conservation priority.

The habitats

A general overview of the habitats was provided in the previous survey report of 2007. This chapter summarizes the major aspects that are the most relevant to the ecology of the upper Sebuku area where the elephant herds roam.

A large part of this area has elevations below 100 m above sea level (asl), but toward the north and west elevations rise when the hilly and mountainous areas are reached. The highest elevations measured here were above 900 m asl. Most sections of the valleys of the Agison, Sibuba, Apan and Tampilon rivers however remain at low altitudes up to the far upstream areas.

The geology of most of the area is of sedimentary origin, with rock mother material consisting of sandstone and some finer textured rocks. Metamorphic material can be found in some locations.

Most areas of the upper Agison, the upper Sibuda, the upper Apan and the upper Tampilon consist of rather high sedimentary mountains with random orientation. These terrains with often steep slopes in many different directions are less suitable for elephants. Each of the river valleys of these areas are nevertheless surrounded by narrow plains, and these are the locations where the elephants generally wander. The Agison river flows some 20 km further from the northern headwaters in Sabah to the south and the Sibuda river also springs in Sabah. The river valleys along these upper sections form natural corridors for the elephants traveling to and from the northern habitats.

Metamorphic hills with random orientation comprise parts of the lower Sibuda and Agison watersheds. These areas are lower, but slopes are often quite steep and the orientation in various directions leaves not much terrain for straight elephant routes.

Most other parts of the lower Sibuda and Agison consist of elongated sedimentary ridges that are approximately parallel orientated. The terrains are not too high and the parallel orientations provide foot slopes and small valleys where elephants can travel easily.

Sandstone cuetas can be seen between the upper Apan and upper Tampilon rivers. These mountains have very steep sides on one side and are avoided by elephants.

The lower and middle sections of the drainage areas of the Apan and Tampilon rivers consist of hillocky sedimentary plains.

Solitary male elephants have no problems with crossing these terrains. Elephant groups with calves however tend to avoid any hills and will usually wander only through the flat plains. Therefore only selected locations along the rivers and more inland plains in between hills will be used by elephant herds.

The plain around the lower sections of the major rivers are covered by Lowland Dipterocarp forest. This forest type is dominated by trees from the Dipterocarpaceae family, in this area mostly *Shorea*, *Hopea* and *Vatica* species. Many other tree species from many different plant

families grow in a high variety of mixtures. These forests have originally a closed multi-layered canopy of 20 to 40 meters high, with many emergent trees of up to 60 meters high. Nearly all of the lowland forests here have however been logged and the structure of the remaining forests is much more open, with a lower overall canopy and very few emergents left. The proportion of trees from families such as Moraceae, Euphorbiaceae, Rubiaceae and Lauraceae is higher in these logged forests than in primary forest. More open spots with herbaceous vegetation occurs, particularly after a second round of logging by local communities.

The transition from lowland Dipterocarp forest to hill Dipterocarp forest usually occurs in Borneo at an elevation of around 300 m asl. The vegetation structure and species composition of hill Dipterocarp forest is different and has at least theoretically more fruit-producing trees available for elephants. Most of the hill Dipterocarp forests have been logged as well but the canopies are usually still rather closed, as the number of commercially valuable trees taken out is lower than in lowland forest.

Pure riparian forest comprises only a narrow strip along the riverbanks, dominated here by *Dipterocarpus oblongifolius* and several other species mainly restricted to this habitat. Riparian forest in a wider sense also includes the river plains that are occasionally flooded or in another way influenced by the river. These sites usually have a rather dense vegetation structure and many tree species that often produce fleshy fruits. The riverbanks of even remote sections are often disturbed or influenced by people who spend time here. Vegetation is cut and small to large volumes of wood, rattan and other products is harvested. At some sites people might have planted bamboo, or at least stimulating their growth by removing other plants. This is sometimes also done for fruit trees such as durian. Riparian forest is a very important habitat for elephants, especially the more open locations where they find many food plants. They frequently bath in the adjacent river. Elephants spend indeed most of their time in river valleys, in and around riparian forest.

The higher mountains are covered by lower montane Oak-Myrtle forest (named so because of the high proportion of Fagaceae and Myrtaceae trees), which shows several variations in this area. In the upper Tampilon mountains for instance are locations with a form of lower montane heath forest.

Montane forests are hardly relevant to elephant habitats as they do not venture into the mountains here.

More detailed descriptions of use of the various habitats by elephants, based on new information and insights following the latest surveys, will be provided further on in this report. This is of course strongly related to choice and availability of elephant food.

Elephant distribution

The distribution of the elephants in East Kalimantan as was described and mapped in 2007 was mainly confirmed after these new surveys and investigation.

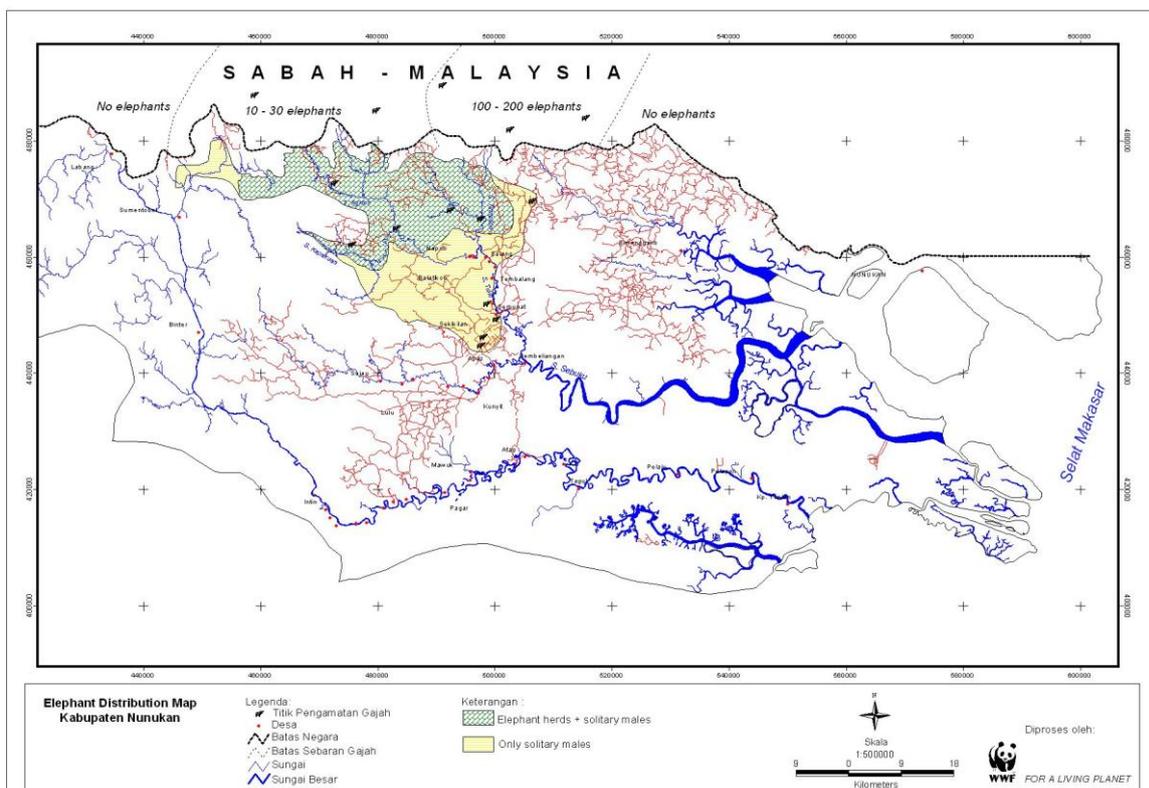
The easternmost range of distribution might however becoming somewhat reduced.

Elephants now very rarely enter the Sibulu river valley. It was confirmed that this area is only visited by solitary males, and only occasionally. The solitary males nowadays spend more time around the village of Tinampak instead.

Between 2007 and 2012 many additional field observations were conducted on the behavior and movements of solitary male elephants.

In Sabah a program of satellite collaring of a numbers of elephants was conducted and this has yielded very much information on habitat use, home ranges, elephant movements, behavior and threats. None of the collared elephants was from the population near the Kalimantan border but a planned additional collaring program will endeavor to include these.

After the previous studies it was concluded that the total extent of the area that is being used by elephant herds is 49,500 hectares. This is indeed the overall area of locations that are suitable habitats and that have been used one time or another by elephants. However, the elephant groups are extremely selective in the choice of terrain types where they wander and forage only in certain parts of a area of suitable habitats. At a detailed level it should be kept in mind that the area that is frequently used by elephant groups is much smaller than the asserted 49,500 ha.



Behavior of solitary male elephants

The behavior and movements of solitary male elephants was extensively described in the previous study report. This provides a good insight in the way these elephants wander around and forage. At the time of this study the area of community oil palm plantations was still very small, while nowadays this has significantly expanded.

Solitary male elephants have continued to enter the southern habitats from time to time. In December 2011 and January 2012 a solitary male elephant was again followed for a few days and this yielded additional information on behavior. The following description therefore serves as an update to the previous studies.

In the beginning of December 2011 a solitary elephant returned to the southern part of the Sebuku area, even though no elephants had come to the area for more than one year. This solitary male elephant was staying around the village of Sekikilan, where he was looking for food during nighttime and resting during daytime. The main food taken by the elephant consisted of sprouts or cores of oil palms and fruits from forest trees. The elephant had already destroyed about 50 oil palms during a period of less than two weeks. A small team followed this elephant for some hours to make observations about his behavior. He did not display any aggression and was not very scared either, and in the end the elephant crossed the Tulid river, which is quite wide at this location. This was the first time that the people of Sekilikan could see an elephant crossing the river during daytime.

When the survey team returned to Sekilikan in January 2012 the solitary male elephant (which had arrived one month earlier) was still around almost every night destroyed oil palms as well as rice and cassava planted by the villagers. WWF was asked to look for a solution from the problem and once again check the impacts and behavior of this elephant. The next day all team members was to the field to see the damage and then look for the elephant that was somewhere downstream of the village. After a few hours following the trail it was found that the elephant has already crossed the Tulid river and so a small team continued the search at the other side of the river. Close to the riverbank a remarkable observation was made. The carcass of a wild pig was found that was killed by the elephant, with fresh tusk marks cutting deep in the body of the pig.



1 Bearded pig killed by elephant

This pig was likely killed while fighting with the elephant for some ripe *Artocarpus* fruits that had just fallen. This was the first time that such an observation of an elephant killing another mammal was made in Kalimantan.

About four hundred meters from this site, the elephant itself was finally found, while he was resting behind dense shrubs and a big tree. The body height was estimated at 2.6 m and the tusks were of medium size. The age of this adult was estimated between 15-20 years old. The shape of the body and the tusks, although larger now, resembled those of an elephant that was observed in the same location in 2007, and it is likely that this is the same individual.

Every time we tried to come close to the elephant he would get away, which made it very difficult to make a decent photograph. The elephant did not actually run, but walked rather fast while crossing streams, dense shrub land, thorny rattans and fallen tree trunks, without any difficulty at all. The elephant frequently defecated and occasionally ate some *Artocarpus* fruits while walking. After walking this way for a few hundred meters the elephant would stop and hide, until we approached it close (<8 meters), and would then suddenly get away again to the next hiding place. The elephant did not seem to be very scared and we sometimes had the feeling that he was playing with us. This impression was strengthened by the fact that the elephant never really tried to get far away but just keep moving in big circles.



2 Solitary male elephant

Land use and the impacts on elephants

Many land use changes have occurred since 2007.

A new oil palm plantation was established in the vicinity of the village of Salang. Oil palm plantations that already existed in 2007 have further expanded. Many local communities from Tinampak, Sekilikan, Semunat and others have started their own oil palm plantations. These local community plantations might start as small areas but are gradually expanding all the time as it is easy for the local inhabitants to clear a piece of forest every now and then.

The new pulpwood (*Acacia*) plantation between the Tulid river and the Mayo hills is now completely developed. Local communities have so far not been interested in planting their own fast-growing tree plantations.

A new road from the village of Sekilikan to Salang in the north was constructed, but it is not clear yet whether this road has an additional large impact on the solitary elephants.

This report deals however mainly with the elephants and elephant habitats in the very north of the Sebu area, from the watershed of the Agison river in the west to the Tampilon river in the east. This area is still mainly under forest cover, but has a long history of logging. Logging operations here were started in the late 1970's by PT Yamaker. Later on eastern part (the Apan and Tampilon areas) was taken over by PT Inhutani I. After logging this area for several years operations were concluded about 10 years ago. The western part was taken over by PT Meranti Tumbuh Indah and this company is still active with logging operations in certain upstream locations.

Illegal logging took place in several locations, both large-scale as well as small-scale operations. Illegal logging is devastating to the ecology of the logged-over forest and habitats, as it takes out nearly all the remaining trees that are supposed to provide for the regeneration of the forest where many mature trees were harvested. A forest that is logged by a timber company, and subsequently raided by illegal loggers cannot possibly recover within the lifespan of an elephant.

At present, almost the entire area of habitats for elephant groups is within the logging concession of PT Adimitra Lestari. This company is committed to obtain certification of sustainable forest management. Protecting the elephants and their habitats is an important aspect of the certification requirements.

Managing such a wide area is not an easy task. Notwithstanding all good intentions, illegal logging activities can still occur. A reminder of this unpleasant fact was the discovery of an illegally constructed logging road in the upper Tampilon area by an unknown outside party.

The distribution and behavior of elephant groups

It was already known from previous research that elephant herds are found only in the northernmost part of the Sebuku area. The herds are generally so small that it is more appropriate to call them “elephant groups” instead. These groups always consist of one or more adult females and often one or more calves and one or more juveniles.

The habitat of elephant groups in the northern part of the Sebuku area can be sub-divided into four different areas. In the western part are the watershed of the upper Sibuda river and the drainage area of the Agison river (from here on referred to as “Sibuda area” and Agison area”) and in the eastern part are the drainage area of the Apan river and the watershed of the Tampilon river. Each of these four areas were investigated for elephant distribution and behavior as well as to obtain further ecological information, particularly vegetation types and geomorphology, on the habitats.

The Sibuda area and the Agison area were surveyed simultaneously by two teams, using the same survey methods. In this way it was ensured that all elephants that were at that present in the western habitats could be detected. This could be achieved by comparing the times that all individual elephant traces were made.

The Apan area and the Tampilon area were surveyed in the same way a few months later, during the height of the fruiting season of many forest fruit trees.

Direct sightings of female and juvenile elephants in the Sebuku area are very rare. Even the people that frequently enter the habitats of the elephants groups, the local hunters, collectors of forest products and workers for logging can only tell of a few encounters. This is in strong contrast with the solitary male elephants, which can be seen easily once they enter the southern habitats. The elephant groups of females and juveniles are only found in remote locations and will always avoid noise and disturbances. The investigations on the elephant groups and their habitat utilization were conducted mainly through the detection and analysis of traces (though it included a peculiar direct sighting). Since the elephant is such a distinctive animal, the traces can provide much information and are not hard to detect. The following traces were analyzed during the investigations:

Footprints

This is the most informative type of trace to determine the number of elephants, group composition and the way they move around. The front leg and hind leg prints of each individual elephant can be measured, as well as distances between prints as well as the depth of the prints, taking into consideration the soil conditions. The measurements differ for each individual and with the total number of elephants in the Sebuku area rather low it was possible to identify each single elephant from various locations. Footprints along the rivers get usually washed away by heavy rain and flooding of the river within a week, but can last much longer inside the forest or on dry land with loamy soils.

Trails

Certain locations have been used as elephant routes for such all long time, that in the course of years clearly visible trails have developed. This almost looks like a man-made trail, with very little low vegetation, somewhat compacted soil and many footprints. One of the best examples was found in the upper Agison area, where in a certain locations nearly all elephants must pass along a narrow riverside in between the steep banks of the Agison river and the steep slopes of a mountain ridge. It should be possible to estimate how many years such a trail has already been used.



3 An often used elephant trail

Boli (dung)

Elephants frequently defecate while on the move and their faeces, called boli, are hard to miss. It is worthwhile to measure the diameters of boli and the number of boli at a heap, as these measurements give an indication of the size of an elephant, and thus a rough determination of the individuals. It can be deduced from the level of decay of the boli how many days or weeks ago the stuff was dropped.

Analyzing the contents of the boli can provide more information on the elephant diet. Elephants usually chew their food diligently, but often pieces of seeds and fibers can still be recognized.

DNA can be derived from fresh dung, which have a thin mucus-like layer on the outside of the boli. However, this is only valuable if the sample is collected within 24 hours, sometimes

up to 72 hours in very favorable weather condition. If the sample is collected too late then it will be already too much degraded, as the DNA rapidly deteriorates.

Rubbing marks against trees

Elephant skins are often covered with a thin layer of mud and when they rub against a tree bole or a branch, whether intentional or just by passing through, this will leave a mark of mud. It is very useful to measure height and/width as this provides a good way to estimate the body size of the elephant. It is also possible to get an indication about how long ago these rubbing marks were made.



4 Measuring the height of rubbing marks

Feeding traces

The marks and remnants of places where elephants had been feeding are extremely valuable as our major source of information on the elephant diet and the habitat preferences. After identification of each species it is assessed which plant parts are eaten (fruits, leaves, buds, cores etc), the volume eaten, and whether the elephants have any strategy for certain species. For instance, elephants carefully select the bamboo shoots to eat, and with a certain fern species they make sure that the plants are not destroyed but can be visited again to eat the young leaves and shoots. The locations of all elephant food species are recorded as well as their specific habitats.

Investigating these feeding traces throughout the area yielded a great amount of information on feeding and habitat use, and this will be presented in greater details in the next chapter.

Salt water springs cleaned by elephants

Small salt water springs or salt licks are known from many locations in East Kalimantan and many local languages even have a special word for it. The water is usually not really salt but just slightly brackish, in various degrees. These springs provide a good source of additional minerals for many mammals and birds. Elephants are the only animals that actively clear larger areas around such a spring. The salt water springs of the upper Agison and upper Sibuda are major elements of the elephant habitats.

Sleeping places

Occasionally surveyors come across a location where an elephant had been lying to take a rest. Given the large size of the animal these sleeping places can be easily recognized. The sight of flattened vegetation, leaf litter and top soil however disappears after a few days. It is useful to measure the area of the sleeping place, as to get an estimate of the body size.

Elephant wallows

Wallows are holes that are dug or enlarged by animals to serve as rain-fed mud baths, and are often used periodically for many years. Elephant wallows are occasionally found particularly in the southern parts of the elephant habitats. These are considerably larger than the common wallows made by bearded pigs. It is possible the some of the elephant wallows were shared with or taken over from rhinoceroses that formerly lived in the Sebuku area. The elephant wallows are measured and often present interesting traces such as prints and tusk marks.



5 Elephant wallow

The Sibuda area

Collection of field data was conducted by following the Sibuda river from the estuary in upstream direction all way to the upper section to the international border with Sabah, Malaysia. The riversides and the valley of the Sibuda form an area that is frequently used by travelling elephants where they can find sufficient food and drinking water. There is also a small but important salt water source in this area that is often visited by elephants and therefore was included in the survey objectives. The daily life of an elephant is strongly connected to rivers and streams, needed for drinking water and refreshment of the body temperature. The locations where elephants passed by are generally easy to recognize. Trails in shrub land and sense forest undergrowth remain open for several weeks. Footprints on sandy riversides also remain for some time, until these get washed away by rain or flooding of the river.

Travelling for the Sibuda river survey started from the Tulid river, at the village of Tinampak 1, by using three small boats (motorized canoes). It took two days of travel time by boat to reach the downstream section of the Sibuda river. Travel time is strongly dependent on the water level of the rivers here, which can rise rapidly after heavy rains. The survey was assisted by members of the local communities who know the access routes to the Sibuda river and the areas that are potentially frequently used by elephants. Further travelling by boat from the downstream to the upstream section of the Sibuda was not possible due to the many high rapids and rocks in the river.

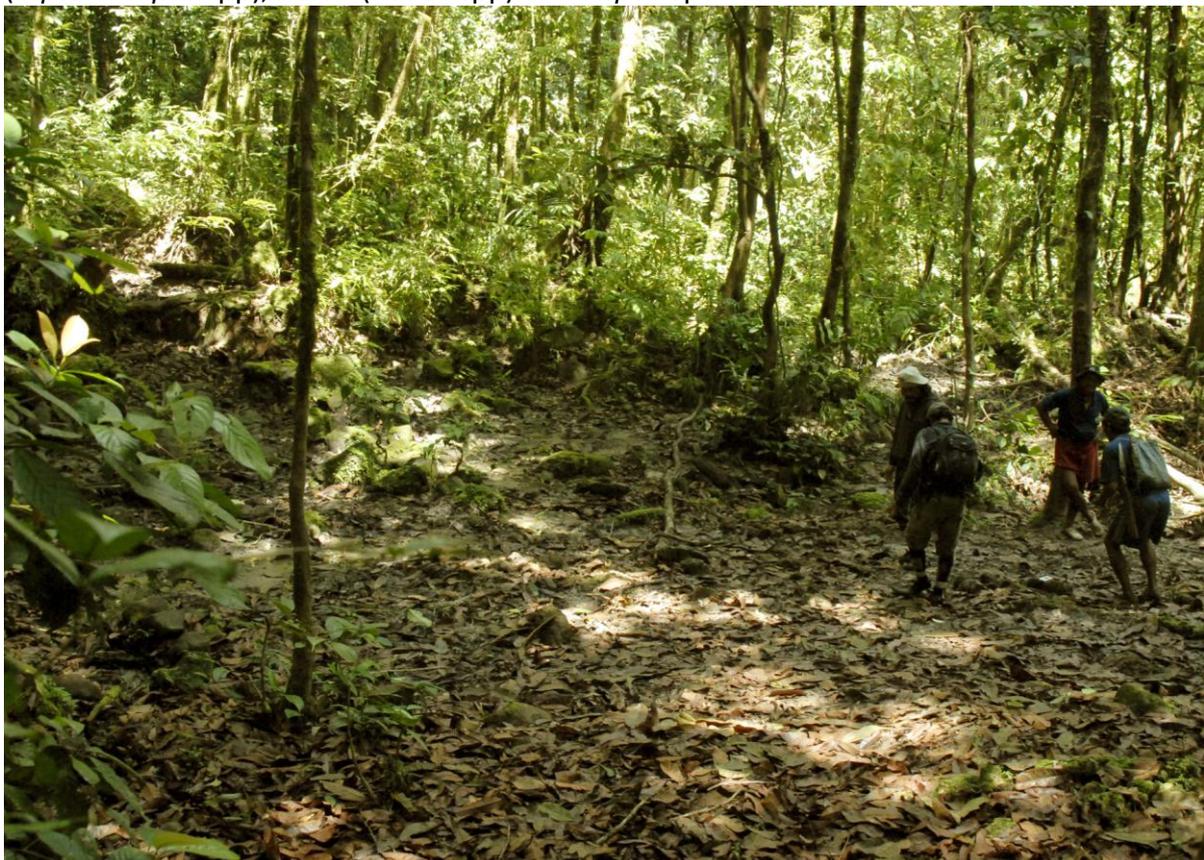
The survey from the downstream to the upstream sections of the Sibuda river took three days, during which a camp was built every evening (flying camp). The actual data collection survey could thus been conducted every day from morning to late afternoon. Data collection included the following: elephant traces that were found such as faeces, footprints and tracks, feeding traces, and traces of elephants rubbing their bodies on trees. All these traces were measured, described and photographed. Ecological information that was gathered included the locations of each elephant trace, the habitats, the food sources and locations of salt water springs.

The analysis of the population estimation was conducted through measuring the sizes of elephant footprints and droppings, by taking into account the approximate age of the traces in the various locations. Each individual of an elephant group usually has specific (different) footprint sizes, which also varies for male, female, adult, sub-adult, juveniles and calves. The occurrence of different sizes of footprints in different locations provides a good overview of all the individual elephants and groups in a wide area, based on the estimations of the ages of the footprints.

The analysis and identification of the major elephant habitats could then the done by consolidating the directions of the traces left by the elephants, the areas that form food resources and the salt water sources, which were all mapped from GPS coordinates taken in the field.

The first elephant footprints of this area were found about 1 kilometer downstream from the estuary of Agison river into the Sibuda river. [note: the Tulid river is by some local communities already named Sibuda upstream from the middle section of the Tulid] This area is part of a wide valley with flat terrains, and is covered mainly by young secondary vegetation with several locations of grasslands and bamboos while large trees are rarely seen. The valley is however surrounded by high hills covered by dense forests with still many big and tall trees. This location is periodically used by elephants for short periods while traveling through the area. Elephants feed on a limited number of food plants here for one day, or perhaps a few days, before moving on to other feeding sites. Many old as well as new elephant footprints were found at this location and the most recent footprints was from an elephant group that visited less than a week ago. Naturally also droppings, feeding traces and rubbing marks were found. Most of the old footprints were not clear anymore, which made it impossible to determine whether these were made by the same elephants or others.

The downstream area of the Sibuda river up to the middle course did not reveal any elephant footprints. This area comprises mainly of hilly terrain with relatively steep and high slopes, covered by good forest with a high densities of trees. The forest of this area is partly in primary condition and has a high humidity, which is indicated by the many leaf leeches as well as ground-dwelling leeches. Many large trees are growing here, mainly from the Dipterocarpaceae family, such as meranti species (*Shorea* spp), Keruing species (*Dipterocarpus* spp), Resak (*Vatica* spp) and *Hopea* species.



6 One of the salt licks of the upper Sibuda area

The upstream section of the Sibuda river has several tributaries and a particular area with many of these small rivers is called Naliwan by the local people. In this Naliwan area several elephant footprints were found which were already quite old, made about two months earlier. Apart from footprints, also old droppings and traces of elephants rubbing against tree boles were seen. Most of the footprints were already unclear and disappearing, caused rainfall erosion, but some were still good enough to be measured. The elephant dropping had already changed by decomposition by micro organism. This area is undulating and the forest has a rather high density of somewhat larger trees. This shows that elephants are not entirely restricted to flat terrains such as river valleys but will also use more hilly terrain from time to time, particularly when crossing from one valley to another.

In the area further upstream (from the Naliwan area) is a location with a salt water source, which local people call "sopon". Many elephant traces were found in this site, in the form of footprints, droppings (faeces) and elephant body rubbing marks on trees. The most recent elephant traces were estimated to be about one month old, with elephants dropping that already started to fall apart and become rotten or decomposed. This area has a rather high elevation and the terrain is somewhat rocky, with small springs in depressions of rocks and soil.

The area in the vicinity of the salt water source is likely also used by elephants for resting during their journeys. Many traces were visible of flattened shrubs and weeds where elephants had slept previously. The main reason for elephants to come to this area is to drink the salty water, which provides them with supplementary minerals. Otherwise the food sources are limited here with the rocky conditions and rather dense vegetation of smaller trees.

The area with the salt water spring is located very close to the border area with Sabah, Malaysia, less than 1 km below the hill summits that form the border. During the survey the team reached the international border between Indonesia and Malaysia and found a border post/pole with number B323. An abandoned logging road, partly overgrown with young trees, with a length of 3-4 km from the border into Kalimantan Indonesian territory was seen in this area. This is a remnant of former illegal logging activities carried out by a Malaysian company in 2005. The people of Sebuku managed to put a halt to this and confiscated some heavy machinery at that time.

The Agison area

The first evidence of the presence of elephants in the area is already visible at the starting position of our surveys, the village of Tinampak. Here we found traces of feeding and footsteps of adult elephants. These were probably made by solitary male elephants. Some of the newly planted oil palms were disturbed by them.

The journey upstream of the Tulid river passed by the Apan estuary. The drainage area of this river and the Tampilon river further upstream is also part of the elephant range and will be described later.

A stretch of large rapids were encountered after some time traveling on the river. These are actually the only seriously dangerous rapids of the entire river stretch, consisting of large boulders blocking parts of the river. All other rapids are more of the too shallow water type, and are hardly taken seriously by people from the interior of East Kalimantan. The upper sections of the Agison and Sibuda rivers are filled with large to enormous boulders and rock outcrops, making these upstream sections unpassable or at least unnavigable.

Along this first stretch of the river are many rather open riversides, the results of long-term use for agriculture by the local communities. Here are some villages, including the village site of old Naputi, which was abandoned by the majority of the inhabitants.

A camp was made the estuary of the Kasusui river.

The next day the journey continued further upstream. The riparian forest along this stretch of the river is generally already in a better condition than in the downstream area. Many giant *Dipterocarpus oblongifolius* trees are still present, and grow like hanging over the water. Many epiphytes are growing at the stems of these trees, often providing a colorful sight.

The first tracks of elephant families along the river were found at a location further upstream close to the estuary of the Agison. Very recently, 2-3 days ago, one juvenile and two adult elephants passed by while foraging in this area. The two adults were probably females, while the juvenile elephant had already reached a considerable height. It was possible by checking mud markings on a branch to establish the height of this juvenile elephant at 160 cm.

The elephants spent several hours at this location while feeding. Elephant droppings (boli) were found at four places. It was rather difficult to make a good estimation of the age of the footprints and boli, as heavy rain of the previous days had washed away many parts of the traces. It is however very likely that elephants frequently visit this location, as older prints and older boli with an abundant growth of mushrooms were also found here. The older traces were estimated to be made about one month ago.

The vegetation of this location consisted of secondary shrub land and small trees, with several large bamboo clumps.

The elephants were feeding on bamboo shoots and were very selective in doing this. They break away older bamboo stems to reach the young bamboo sprouts. Sprouts that are too old and are already developing into stems are also avoided. This selective behavior and the

fact that elephants move around all the time and thus only occasionally feed on ensure that the bamboo clumps disappear.

The elephants were found to feed on rattan as well. They select the fresh ends, usually of older rattan plants that have already grown into climbing stems.

The next elephant footprints were observed not far after entering the Agison river to travel upstream. It was found during the survey that either recent or older elephant footprints were present along nearly all of the sandy flood plains of the Agison river. These sandy flood plains look like beaches and are sand banks that are frequently flooded by the river after heavy rainfall. The elephant route along the riverbed of the Agison follows a clear pattern in which the elephants walk from one bank to the other, crossing the river wherever needed where it is convenient to reach the next riverbank. Banks can be either sand banks or stone and pebble banks, although the elephants show a preference for walking on soil instead of rock.

The characteristics of the Agison river change further upstream from a relatively quiet lowland river to a more dynamic upland stream. This becomes particularly evident during dry periods with low water levels, by which many of the rocky banks and part of the riverbed becomes exposed. Navigation of the river becomes more of a challenge, and while traveling upstream one of the boats capsized. The long-tail engine sank to the bottom but could be recovered and repaired, but part of the logistics could not be saved.

The most recent and most frequently seen elephant traces were the footprints of a group of four elephants. These were found on many sand banks and were made by three adults and one juvenile elephant. Apart from some occasional browsing of Zingiberaceae and shrubs, hardly any feeding traces were observed. The footprints were about 2 weeks old.



7 Impression of the Agison river sides

At a distance of about 2 km further upstream, more recent traces of about 2-4 days old were found from another small group of elephants. These tracks consisted of the footprints of three elephants, probably a small family. One was a large adult, most likely female, elephant. The second was a juvenile and the third a baby elephant. Both juvenile and baby were probably the offspring of the same adult female. Several heaps of boli were found, indicating that the elephants were walking at a leisurely pace. Feeding traces were however hardly found.

Further upstream the footprints of four elephants were seen. This group consisted of two adults, a juvenile and a baby elephant. It is not sure whether this was the same previous group of three elephants, temporarily accompanied by a second adult. The sizes of the baby elephant matched, but the juvenile was slightly larger.

The Agison has a very dynamic flow regime, with frequent flooding but also long periods of receding water levels. Older elephant footprints can be seen all the way along the upper section of the Agison river. Most of these are of large adults, these imprints last longer after rain and flooding, but sometimes footprints of juvenile and baby elephants are still visible as well. Feces (boli) are found in a few locations, but these rapidly wash away during floodings. Traces of feeding are rarely seen, which could indicate that the elephants travel through this section of Agison rather fast. Footprints of other wildlife are abundant. The most common prints are from sambar deer (*Cervus unicolor*) and bearded pig (*Sus barbatus*). Other often seen footprints include those from larger mousedeer (*Tragulus napu*), long-tailed macaque (*Macaca fascicularis*), monitor lizard (*Varanus salvator*) and a civet species, probably *Viverra tangalunga*.

The rocky shallow riverbed of the Agison and the many rapids caused by large rocks in the river make it impossible to travel further upstream by boat. Surveying the river valley on foot gives the good opportunity to follow exactly the same routes that the elephants walk, which is mainly along the banks and river plains.

Much of the hilly terrain on both of the river still show the signs of former logging activities. Old logging trails made with bulldozers and tractors are still visible but the forest is slowly regenerating here. Illegal logging operations coming in from across the border were halted some years ago before the impacts became too devastating.

Walking along the river is mainly done by following the sand and pebble banks and avoiding steep river sides, which implies crossing the river over and over again to get from one flat bank to the other. The elephants do the same, similar even to the point of avoiding the edgy rocks as much as possible. The crossing points are also more or less the same, and these locations, where young elephants are more vulnerable, can be easily identified and mapped. Elephant footprints were found in many locations of banks and above crossing points. Most of the prints were 4-8 days old and boli were found at a few sites.

Nearing the international boundary with Malaysia, the Agison river become narrower with more large boulders in and around its riverbed. The elephants use an undulating area slightly more inland to cross into the river valley to avoid these large rocks.

Further to the north the riverbed becomes wider again and can be followed by crossing from bank to bank. A wider river plain further upstream is a more easy terrain and here and often used elephant trail was seen. This 3 meter wide trail is probably several decades old and bears the signs of many elephant footprints. Bamboo shoots and Zingiberaceae plants were occasionally eaten along this trail.

Upstream from this area is a very wide flood plain, in certain places up more than 100 m wide, with several locations where landslides had occurred along the steeper banks. This area is all part of the Agison riverbed and consists of sandy banks, rock banks, small pools and the permanent streambed of the river. The many dead and often dry tree boles are proof of the forces of nature during flooding.



8 The salt water sources of the upper Agison

Finally the salt water sources are reached.

These salt licks are located at a flat river plain surrounded by low hills. The location comprises a wide muddy plain with many pools of shallow water. Most of the higher vegetation was removed or trampled by elephants and other animals coming to drink from the water. Animal footprints were abundant, and these are all recent ones, since the imprints do not last long in the muddy wet soil. Most prints were from deer, bearded pigs and barking deer. The latest visit of elephants to this area was also clearly visible. These were the footprints of one adult, one juvenile and one baby elephant (calve). The elephants probably spend some time in this area as numerous boli as well as feeding traces were observed. Close

to the salt water sources is a site with many ferns, of which most of the sprouts were eaten by elephants pushing away the older fern clumps.

Local villagers reported on our way back about a baby elephant that had fallen into a deep hole. When they first discovered it, the elephant was still alive and making noise. The mother was nowhere to be seen and had probably already left, giving up any attempts to rescue the young.

The next time the villagers went to check the elephant, four days later, the elephant had already died. When the survey team arrived two days later, the dead animal was already in an advanced stage of decomposition. Most of the organs and part of the skins were gone. The skull was exposed and partly eaten by a monitor lizard. Traces at the edge of the hole indicated that the mother had made several attempts to pull the young out of it, but had abandoned the place several days earlier.

The hole was a natural phenomenon, a small spring of a stream, and was four meters deep with very steep sides. The location is at a river plain that is actually frequently used by elephants and comprises generally flat terrain along the river. The elephant should know this location well but the calve was merely very unlucky to fall in the only deep hole in this place.



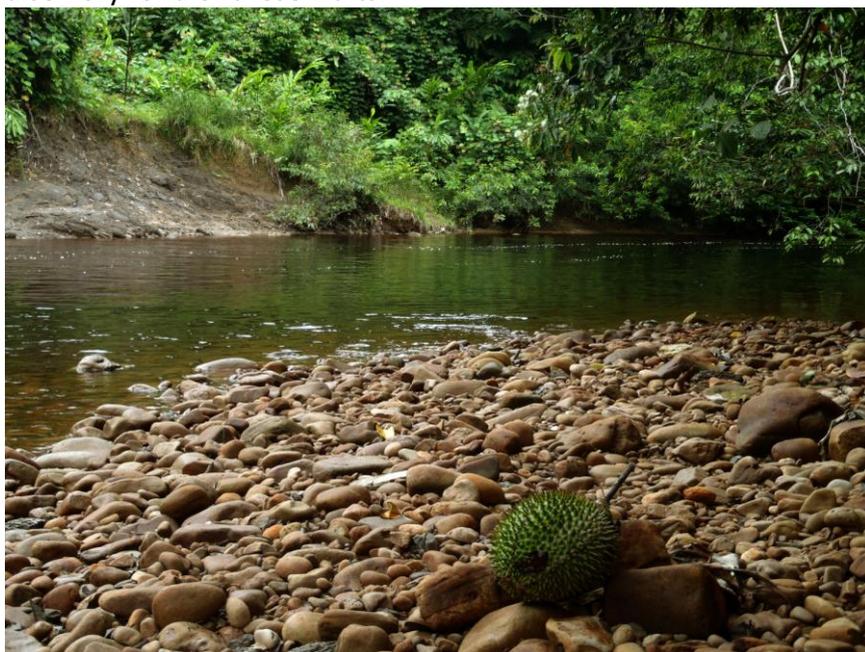
9 Dead elephant calve in hole

The Tampilon area

The estuary of the Tampilon river can be reached by traveling by boat upstream into the Apan river for about two hours. The Tampilon should not be considered a true tributary of the Apan, since both rivers are more or less of the same size and have also drainage areas of similar extent. There is a clear water divide between the northern upstream drainage areas in the form of high mountain ridges.

The forests on both sides of the Tampilon river were part of former logging concessions. After the logging operations were finalized, small-scale illegal logging continued, taking out most remaining commercially valuable trees. The forest is, notwithstanding the many logging activities still in a relatively rather good condition with a quite natural structure. Many large *Koompassia* trees are still standing, but very few Dipterocarpaceae trees are left. Beehives can be seen hanging from the branches of several *Koompassia* trees and local people occasionally harvest honey in these locations. The under storey of these forests is usually dense with many saplings and herbaceous shrubs.

Some sections of the riversides are covered with good riparian forest, including medium-sized *Dipterocarpus oblongifolius* trees and many *Arenga undulatifolia* palms. Large durian trees occur in several locations. Most trees are of the common durian species, *Durio zibethinus* but some trees of other species, *Durio dulcis* and *Durio kutejensis*. The locations of these trees are well known to local people and during fruiting seasons boat trips are often made to collect the fallen ripe fruits from under the trees. This collection needs to be done as soon as possible since several mammal species such as bearded pigs and macaques are also very fond of these fruits.



10 Impression of the lower Tampilon river sides

Elephants occasionally cross the river in this downstream section. They use a number of favorable established crossing points for this, which have shallow sloping riverbanks and

often a rather open vegetation cover. One of these crossing points was discovered with elephant footprints still vaguely visible. These prints were about two months old and made by a single, probably male, elephant. It is very likely that the footprints are from the same individual that was still around Sekikilan at the time of survey. Elephant groups are less often observed in the Tampilon area than in the Agison and Sibuda areas.

The Sibulu river is an eastern tributary of the Tampilon and it was reported that formerly elephant groups occasionally entered the Sibulu river valley. This is however not happening anymore and the only elephants getting all the way east of the Sibulu are solitary males.

The Tampilon river is only navigable for less than 10 km upstream, after which river becomes too shallow for boats and with too many rocks. This is also the place where the flat plains make way for a hilly and further to the north a mountainous landscape. The transition from flat to undulating terrain begins in the vicinity of the Bosoi river, a western tributary of the Tampilon. This is at an elevation of only 80 m above sea level.

Traveling had to be continued on foot, by following an old abandoned logging road. The forest conditions here are quite poor, with not much of the original vegetation structure left intact. Most sites are dominated by *Macaranga*, but many other secondary forest species are present as well. The understorey is generally dense.

Some remnants of good natural forest are present along the rivers and the highest summits. The entire area still harbors a high diversity of bird species. These including several remarkable species such as the great argus pheasant, the rhinoceros hornbill and the helmeted hornbill. The latter species is said to be an indicator of good forest conditions and it is a good sign that this charismatic bird is still around, though it seems to be highly dependent on the good forest remnants from where it forages to the degraded forests. Bornean Gibbons (*Hylobates muelleri*) could be heard doing their morning calls at several locations and appear to be still common. Direct observations of this agile primate were made in logged-over forest but with a high canopy.



11 Summit of a mountain ridge of the upper Tampilon area

The entire area is very hilly with several steep slopes. Abandoned logging roads follow the main ridges and several rivers, ranging from 2 to 10 meters wide, intersect the area. The former logging operations can also be witnessed by some broken equipment left behind as well as small log ponds and camp sites. Coal exploration was conducted in this location at least twice and these operations also left behind some equipments.

Several rather steep summits occur in the central part of these hills. The altitude of one of the summits was measured to be 928 m asl. This summit consisted of flattened sandstone rock outcrops. Some thin layers of exposed coal are present in a few locations.

The soils of these high elevation terrains are very shallow, often consisting of a layer of only 20 cm thick on top of bedrock. These soils become rapidly saturated with water after rainfall, creating marshy conditions on many locations and a high sensitivity to erosion at the slopes. The bedrock consists of various types of sandstone and small limestone outcrops were also found. The vegetation of these marshy locations is quite outstanding and included many terrestrial orchids, *Lycopodium* creepers and rare Nepenthaceae pitcher plants. No less than four different *Nepenthes* species were found in this unique habitat: the relatively common species *N. rafflesiana* and *N. reinwardtiana* but also the uncommon species *N. veitchii* and a species with a hooked crest identified as *N. pilosa*. *Nepenthes veitchii* is a very remarkable species with large collared pitchers and is known only from a few locations in Kalimantan.



12 *Nepenthes veitchii*, upper Tampilon

The area north of these central summits comprises several terrains with long and rather gentle slopes, which could make reasonably good elephant habitats. These locations were heavily logged and most of the present vegetation is species poor-young secondary forest. The steeper summits have some better forests left. It was reported that *Agathis* trees used to grow here, but these were not found during the survey. Not many different tree species were seen and these were mainly Euphorbiaceae, Lauraceae and Rubiaceae. Natural regeneration of *Casuarina* trees is a common sight. However, many locations are degraded and have only a dense herbaceous cover left, consisting mainly of high ferns and grasses. The many terrestrial orchids growing here are all of the same species.

At the northern edges of the long slopes, which stretch for several kilometers, the mountain ridges are reached that form the boundary between Indonesia and Malaysia. The forests cover of these ridges with steep slopes are generally in good conditions.

An elongated mountain ridge with a length of about 6 km is located in between this upper section of the Tampilon and the Apan river in the west. This ridge, with a west-east orientation, had very steep slopes on both north and south sides and many narrow summits. Part of this ridge consists of limestone and these outcrops are often shaped as cliffs, in which caves have formed. A number of these caves form nesting sites for swifts and their edible birdnests are eagerly collected by local people.

The valleys at the footslopes of this mountain ridge can be entered easily from the upper Apan river. Local people visiting the area to collect bird nests and other forest products have reported elephants from this area. These are most likely solitary males wandering around, while elephants groups of females and offspring do not find much suitable habitat here.

When the survey team reached the mountain ridge along the international border, we unexpectedly came across a recently constructed logging road, made 1-2 months ago. The road has a width of about meters and is completed with bridges made of logs across each stream. An excavator was still standing parked beside the road by no operator or other construction worker was present. A stretch of the road was surveyed for about 600 meters and was found to exactly follow the southern foot slopes of the mountain ridges that form the border between Indonesia and Sabah. According to one of the team members, who is working for Adimitra, this road was not constructed by his company. The team members from the villlage of Tinampak said that this road originated from the Malaysian side and was built with the purpose of taking out the timber that is left in the forests of the upper Tampilon and upper Apan. The construction of this road was never reported to the village of Tinampak.



13 Newly constructed logging road, upper Tampilon area

During the survey in the upper Tampilon area, along the river, in the valley and in the hills, no elephant traces were found. According to the local communities elephants sometimes get into this area, but these are most likely solitary males while elephant groups (females and young) rarely move all the way to the upper Tampilon. The elephant situation in the upper Apan was reportedly similar.

This latest field information confirms our earlier suspicions that elephants do not use the upper Tampilon and Apan areas to travel from Sabah to Sebuk and back. Only the corridor in the upper Agison and the corridor in the upper Sibuda are used for this by the elephants.

The major and very important outcome therefore from the Tampilon and the Apan surveys is that it proves and emphasizes that Agison and Sibuda corridors are extremely important to the conservation of elephants in East Kalimantan and need to be preserved as good as possible.

The Apan area

The upstream area of the Apan river was surveyed by a separate team simultaneously with the upper Tampilon survey. In this way all recent elephant records of both connecting locations would be taken from the same period of time, providing a good overview of elephant land use of the entire eastern area.

The Apan survey team traveled for four days until the international border with Sabah, Malaysia, was reached. The first section could be reached by following the river by boat, but the uppermost section could only be reached overland, traveling on foot.

The Apan river has several tributaries, such as the Temadung, Kimono, Bantul, Babulu and the Lakap-lakap rivers. Elephant footprints were found in the lower section of the Apan area, which is in the vicinities of the Temadung and Kimono tributaries. The footprints were however already quite old.

In the upper Apan area no elephant footprints were found. According to the survey team members from the local communities, traces of neither solitary elephants nor elephant groups are rarely found in the upstream area, and are seen mainly around the middle and downstream course of the Apan river. The upper Apan area is mountainous, with several high mountain ridges, steep slopes and even locations with vertical cliffs. Some local people often come to this area to harvest edible birdnests. The volume of birdnests that can be collected is however decreasing, because harvest practices are not managed well.

During previous surveys a good number of footprints and feeding traces of small elephant groups were found at several locations of the lower Apan area. The last time before the 2012 that the Apan river was surveyed was in 2007 and at that time traces of small groups of elephants, comprising female adults and juveniles, were found at several locations, though the majority of these traces in the downstream area.

The lower Apan and lower Tampilon are actually very suitable habitats for elephants since the area is rather flat, with low elevations, and many rivers and streams. Food plants are also widely available. However there is too much disturbance going on for the elephants to feel safe here. Even though the logging companies have left this particular area after many years of operations, still many people come frequently to the area to take out small amounts of timber and to go hunting.

Elephant food

Elephants are very selective in their choice of food sources and only a limited number, with a limited distribution, of plant species are eaten. It should be taken into account that the locations where these food sources are present are protected from destructive disturbances.

Ferns

Terrestrial ferns are common in the area and are particularly abundant at open spots of former landslides and along the rivers. The elephants are however very selective, and only a few fern species are eaten. The most common species *Gleichenia truncata*, growing vigorously at disturbed sites is not eaten by them.

The species most liked is *Blechnum orientale*, which is an up to 1 m high fern with erect rhizomes that form short trunks (pseudo-stems) in full-grown plants. The shoots and young fronds are also edible for humans. The elephants not only eat the shoots but also all but the oldest leaves, though the rhizomes are spared. The species grows fast and by the time the elephants forage again in the same place, many new leaves are available. Another fern species frequently eaten by elephants is *Pteridium caudatum*, a rather common species of open spots along the river.



14 Ferns eaten by elephants

Bamboo

Bamboo shoots is one of the favorite food sources of the elephants of this area. Bamboo clumps are found mainly along the river plains, usually close to the riverbanks. The elephants apparently remember the locations of all the bamboo clumps and incorporate these in their usual travel routes. Some of the bamboo was planted previously by local people either at old settlements, or simply along the rivers to occasionally provide for cooking containers or

other utensils while traveling. Other bamboos, such as *Schizostachyum brachycladum* have always grown naturally in the forests of the upper Sebuku. Feeding on bamboo clumps is an easy way for elephants to quickly fill their stomachs, without the need to search for every single bit of food. It should be noted that the densities (and distribution) of bamboo is limited and therefore to a minor degree is determining the habitats of the elephants.



15 Bamboo eaten by elephants

Rattans

Rattans in their early growing stages are ground-dwelling plants growing on various habitats, ranging from exposed sites to closed canopy shades, on the forest floor. These young rattans are very common in the area. Only after a period of time which could be several years will the climbing stems develop. At this stage the plant often develops a clump of several offshoots. Climbing rattans are also common, but are frequently harvested, especially at very accessible sites along the rivers.

Elephants often eat the young sprouts of mature rattans that have formed climbing stems. This caused the death of the rattan stem, but new stems can grow out from the rattan clump. Several rattan species are eaten but it is not known whether certain species are avoided by them.

Other palms

Apart from rattans, which are abundant, several other(non-climbing) palm species grow scattered in the forests of the Sebuku area. Only relatively few of these palm species provide food for elephants.

The *Arenga undulatifolia* palms is the most important ones for elephants and this species is rather common, particularly along riverbanks and more open locations somewhat further away from the rivers. This species, with its characteristic curly leaflets, remains low as it does

not form real woody stems. New plants usually regenerate from the root system. The *Arenga undulatifolia* palms are very much liked by elephants. The sweet young core of the palm is eaten after removing most of the leaves. Previous research in the Sebuk area found solitary male elephants wandering around from one palm to the other to feed on them. Although the eaten palm does not survive this, usually one or more new palms grow from the same root clump. Some local people such as in the Bahau area frequently eat these palm cores as well, but this practice is all but unknown to the people of the Sebuk area, so there is no competition issue here.

No other erect palms are known to be food sources for elephants. *Oncosperma* and *Licuala* are rather common but are not eaten. The betel nut palms, which are found at most old settlement sites in the area, are also not eaten.

It is almost needless to mention that the introduced Oil palm (*Elaeis guineensis*) is among the most-liked food of elephants.

Zingiberaceae

Plant species of the ginger family, Zingiberaceae, are very important components of the forest floor of lowland and hill forests of Borneo. These plants are also very common in the Sebuk area, growing in various habitats.

Several species of the taxa *Alpinia*, *Etilingera* and probably also others are eaten by elephants. It was observed also during previous surveys that elephants never eat large volumes of Zingiberaceae. Usually only a few plants are eaten, which might be related to small amounts of poisonous substances in the plants.

Wild bananas

Elephants often feed on wild banana plants. They mainly eat the youngest cores of the stems, which they reach by removing the leaves and leaf stalks. The fruits/bananas are eaten only if these are sufficiently ripe. Wild bananas, mainly the species *Musa acuminata* and *Musa borneensis* are very common in the Sebuk area. In open locations such as riversides, roadsides and highly disturbed areas wild bananas can be abundant. Under a closed forest canopy they only occur at some spots.

Pandanus

Various species of *Pandanus* plants grow scattered throughout the forests of the Sebuk area. Occasionally the cores just below the youngest leaves are eaten by elephants.

Grasses and sedges

Fresh leaves of grasses (Poaceae) and sedges (Cyperaceae) are frequently eaten by elephants, but mainly in small amounts only. Wild sugar canes (*Saccharum spontaneum*) often form dense stands along degraded riverbanks and these are often eaten. The elephants are very selective in their choice of leaves and full or push away the older leaves that they do not

desire.

Tree fruits

Elephants eat mainly fleshy fruits. Hard fruits (nuts) are probably not eaten very often by elephants. The major sources of nuts in the upper Sebuk area would be from trees of the Dipterocarpaceae family, but these generally do not bear fruit every year. Most of the Fagaceae of Kalimantan produce fruits frequently and often in large amounts, but trees of this family are not so common at the Tulid, Sibuda and Agison river valleys.

A large number of tree species that produce fleshy fruits are present in the elephant habitats. However the fruits of many of these species grow high in the canopy and do not drop when ripe, and are therefore out of reach to elephants.

Most of the tree species are subject to fruiting periods, which are usually rather short. The availability of fleshy fruits for elephants is therefore limited. This is actually also the case for other larger ground-dwelling mammals. Research in the nearby Kayan Mentarang National Park revealed that the proportion of fleshy fruits in the diets of bearded pigs, sambar deer, barking deer and even mouse-deer is on a year-round average rather low (Wulffraat, Tatengkeng & Salo, 2005).

The fruits of various *Artocarpus* species are very much liked by elephants. All of the ripe fruits fallen from a tree will be eaten by them. Sometimes elephants even push down smaller trees to get to the fruits. Indigestion is sometimes incompletely and the seeds can come out unharmed, and were as such frequently found in the elephant droppings. In this way elephants strongly contribute to the distribution of *Artocarpus* species in the forest.

Ficus trees are some of the few species that frequently produce fruits, particularly the species in the riparian forest. It was observed however that elephants eat only small amounts of these fruits.

The many *Syzygium* trees, in a wide variety of species, can produce large volumes of fruits. Most of these fruits are however small and not very sought after by elephants.

Trees of the genus *Garcinia* are common and the fruits appear to be liked by elephants, given the occurrence of footprints at sites with many *Garcinia* fruits fallen on the forest floor.

According to local informers, the smaller durian fruits are sometimes rolled in grass leaves and then entirely swallowed by elephants without chewing. This would help their digestion systems. This is however a myth. In reality elephants can carefully open the durians and take out the flesh.



16 *Artocarpus* fruits and young leaves eaten by elephant

Tree leaves

The young leaves of *Artocarpus* trees are sometimes eaten and elephants might even pull down a small tree to reach these leaves. Otherwise it was rarely observed that elephants had been feeding on leaves of other tree species.

Tree bark

Elephants are mentioned to occasionally eat some pieces of tree bark. This would be for medicinal purposes or to take some additional minerals. It was observed only once that tree bark had been removed by elephants, so it is probably no common practice.

Additional minerals

Elephants need to consume additional minerals that they cannot sufficiently obtain from plant foods. For this they will frequently visit salt water sources or salt licks. In other locations in Sabah they also use kaolinite clay sources for this purpose. According to some elephant specialists, the distribution of elephants in Borneo might even partly be determined by the presence and availability of such mineral sources (J. Payne, *pers.comm.*).

The salt licks of the upper Sibuda and particularly of the upper Agison are therefore of extreme importance to the elephants and are indeed frequently visited.

The term “salt water source” should not be taken too literally. When I tried the water it did not taste salty at all, it only had a bit more of a mineral taste than fresh water. However even these small amounts of salts or minerals are essential to the elephants.

Last but not least it has to be mentioned that elephants drink large volumes of water. This is readily available from the rivers of the upper Sebuk area, though it might be a limiting factor in certain upland locations.

Habitat use

A general overview of the habitats, based on topography, geomorphology and forest types was provided in the previous report. The latest field research, which was conducted by precisely following the traces of several elephant groups, yielded many more details, enabling a accurate identification of micro-habitats used by elephant herds in the upper Sebuku area.

The habitat use of elephants is mainly determined by terrain types and the locations of the major food plants and salt water springs.

Elephant groups endeavor to follow as much as possible the major rivers and the flat river plains. Only when the river sides are steep, when the river valley has too many large rocks or when they need to cut to another riverside location will they enter more hilly terrain.

By far the most important habitats of the elephant groups are the river plains. These are the flat areas along the larger rivers that can stretch for several kilometers inland, but are usually rather narrow, less than 800 meters, in most locations. It can be asserted that the elephants spend 80% of their time in this river plain habitat.

Most of their food sources grow here, not only in terms of number of plant species, but also in productivity and thus volumes of food available. Adult elephants can walk on rather steep slopes, but the elephant calves appear to have more difficulties with steep terrain and hence their mothers try to use as much as possible the flattest locations. Their habits of doing so have hence resulted in the use of established elephant routes.

The river plains are the habitats of nearly all of the food plants that elephants like most: bamboos, ferns, most *Arenga undulatifolia* palms, most zingiberaceae, most wild bananas, grasses and sedges. Elephants need to drink large amounts of water and the close proximity to rivers ensures a rapid availability of drinking water of good quality.

The elephants usually wander around for a day or so at a larger river plain and even spend more time to rest, before moving on. Particularly in the upstream sections of the Sibuda and Agison areas they cannot always walk through river plains but often need to walk closely along and inside the river beds for some distances.

While walking directly along the rivers, elephants will always use the most convenient locations, in the same way as humans do. The elephant groups will follow as much as possible the sandy flood plains, or sand banks. There is no food available here and elephants usually pass by rapidly, as can be observed from the many footprints in linear patterns. In most locations these sandy flood plains connect to stone banks or rocky flood plains. The rocks and stones at the surfaces of these sites are generally rather large ranging from 10 to 50 cm in diameter. This is nevertheless well passable for the elephants and still better to follow than possible alternative routes higher up the steep river sides.

In many of the upstream areas the elephant groups have to follow the river for considerable distances before they can enter another river plain. The sandy and stony flood plains usually do not stretch for more than 500 meters and are followed by steep river banks with deep water, normally in the inner bends of the river. At the locations at the end of the floodplains the elephants will cross the river, to continue their journey along the flood plains at the

other side of the river. The elephants will stand close together before crossing a river (as could be seen from the footprints) probably to ensure the safety of the youngest elephants of the group. These crossing points are always the same and are routinely used by elephants as well as other larger mammals such as deer. It was interesting to notice that humans choose exactly the same crossing points and although the river can be somewhat deeper here, all crossings can be made without the need to swim.

Elephants have the habit to use wallows in which they can cover their skins with a layer of mud. However, wallows were found neither along the Agison nor along the Sibuda, Apan and Tampilon river areas. This is remarkable since during previous surveys, concentrating mainly on solitary male elephants, several elephant wallows were found in the area further to the south. These wallows appeared to be used rather frequently and occasionally enlarged by the elephants. It is possible that because the elephant groups in the northern habitats spend most of their time in close proximity of a river, and thus can bathe whenever needed, they do not feel the need of using wallows.

Only in the uppermost parts of the Sibuda and Agison area, which are too mountainous for these terrain types, can elephants not follow any river plain or food plain. In these locations are some elephant trails at higher river banks which have been used for many years.

After a long stretch of a very narrow valley, where the Agison river has to pass through several mountain ridges on both sides, the river valley widens again toward the north. The international boundary between Indonesia and Malaysia is located at one of the narrowest points of the river valley. More river plains are located at the locations where the valley becomes wider. At one of the western river plains is a large area with salt water sources. These salt licks are of major importance to the elephants and are probably visited every time an elephant group travels through this area. The entire site of the salt water ponds and close surroundings are cleared from most of the vegetation and elephant footprints are abundant. The salt licks are also very often visited by other larger mammal species. The elephants have several trails to approach and retreat from the salt licks. They spend at least several hours and probably sometimes up to a few days in the vicinity of the salt water sources.

The salt water sources of the upper Sibuda area are much smaller than those in the upper Agison area. Only small sections are cleared from vegetation and the number of footprints is much lower than at the Agison salt licks. It is likely that not all elephants always travel all the way to this location.

Hunters staying around the salt licks are extremely disturbing and will scare away the elephants that need to use and pass these locations. The elephants have no alternative routes, which serve as the only two corridors for moving in and out of the river valleys. The abundance of wildlife makes it interesting to local people to wait hiding near the salt water sources. This occurred in both the upper Agison and the upper Sibuda sites, as could still be seen from the remnants of shelters here.

Elephant groups spend most of their time in close vicinity of the major river. They might venture further into the forest behind the river plains when there are good food sources available, or when they need to hide.

Elephant groups also spend more time in the inland forests when they need to move from one riverside location to another. In the northernmost section of the Sibuda and Agison areas the elephant groups travel from one section of the river valleys to another section and cross more hilly forest terrain for some kilometers. Elephant groups also move away from the river valleys in the lower section of the Tulid and Sibuda rivers, when they move into the lower Apan and lower Tampilon river valleys. The terrain in these areas is more hilly than the preferred river plains but they elephant groups still try to avoid as much as possible the steeper hills and mountain ridges. In these forests the elephants find a more limited number of food plants, which are mainly some *Arenga undulatifolia* palms, rattans, fruits from trees, *Pandanus*, some wild bananas, some Zingiberaceae and tree leaves.

Map with detailed habitat use and routes

The routes

The routes of the elephant groups can now be identified and mapped with a high level of details. All trails were exactly followed during the surveys and GPS coordinates were recorded at every main location. It is even possible to identify all flood plains and river crossing points used by the elephants from satellite images if the image resolution is sufficiently high.

It is clearly confirmed now that the elephants use two elephant corridors. They only travel into Kalimantan from the upper Agison and from the upper Sibuda river valleys. The elephants have been using the area and these corridors for many years. This is proved by the existence of old trails made solely by elephants, which they passed for many years and are clear of low vegetation. The salt water springs in the upper Agison area have also likely been cleared only by elephants since no other animals are capable of removing the trees in such a wide stretch of land.

The salt water springs are “conveniently” located at headwaters and first part of the routes of the Agison and the Sibuda rivers. This was probably also one of the reasons that the elephants choose to start using the Agison and Sibuda river valleys for trekking, when they first ventured into this new area. It is now commonly assumed that elephants of Borneo were introduced; in that scenario they were first settled near the east shore of Sabah and later on (in the course of 200-300 years) they spread over a wider area. After finding these important salt licks they were attracted to move even further south.

By following the Agison and Sibuda rivers further downstream the elephants can utilize very suitable habitats and can travel through the river plains while foraging and follow the rivers over the many sandbanks and rockbanks. When they reach the Tulid river they can continue their journey through some slightly undulating terrain into the river valleys of the Apan and Tampilon rivers. The availability of suitable habitats in the upstream areas of the Apan and Tampilon rivers is limited, as the terrain becomes mountainous with many steep slopes toward the north. The elephants therefore do not have another corridor back into Sabah here. The elephant groups might spend some time in the lower sections of the Apan and Tampilon river valleys, but will then move back to the Sibuda and Agison areas. Here they use the same corridors to move back into the Kelabakan range in Sabah.

In and around the river valley of the lower Tulid river, from the estuary of the Apan all the way down to the south, are large areas of very suitable habitats for elephants. These locations were already discovered by solitary male elephants, which frequently venture into these southern areas. It is likely that elephant groups would have come down as well sometime in the near future, if the area had remained undeveloped.

Presence confirmed

Only relatively few elephants could be confirmed to be present in the Sebuku area the time of the surveys, in July 2011. The elephants occupy a large home range and the largest part of this area is located in Sabah, the Kelabakan elephant range. The total number of elephants in the Kelabakan area was estimated to be 150-200 individuals. A part of this elephant

population includes the upper Sebuk area in its home range. Throughout the year small herds of elephants as well as solitary males travel to the south into Kalimantan and after wandering around for some weeks return to Sabah. A number of different elephant groups travel in and out of the Sebuk area and the elephant groups recorded during one survey are likely other groups than those recorded during another period of time. The total number of elephants coming to Kalimantan is estimated to range between 30 and 80 individuals.

Along the upper Tulid river and the lower Sibuda river the traces of two adult female elephants, one juvenile elephant and one baby elephant (calve) were recorded with certainty. The two of two adult female elephants and their offspring sometimes split and regroup later on.

A group of two adult female elephants and one juvenile elephant went up to Naliwan area in the upper Sibuda area. In the vicinity of the salt lick of the upper Sibuda three adult female elephants could be recorded from very recent footprints. A group of two to four adult female elephants stayed in the same location 2-4 weeks earlier. However, no footprints of a juvenile elephant or a baby elephant could be found at the salt water spring of upper Sibuda. It is possible that female elephants coming in from the south do not bring their young all the way to the upper Sibuda, but return to the Agison route. The route over the terrains along the upper Agison is more gentle to calves and juvenile elephants with very few steep slopes and banks, while the upper Sibuda route is more mountainous.

Elephant footprints can be found everywhere along the flood plains and the river plains of the Agison river and these are easy to follow. At the time of the survey the fresh prints three adult females, a juvenile and a calve could be identified. Older footprints could also found at certain river plains, the elephant path and around the salt water springs. These prints included some very large ones, probably from an adult male elephant.

Unfortunately the elephant calve of which so many footprints were observed was later found dead in a hole along the Agison river. This is actually a very rare observation and local people knew only of a single other case of a dead elephant found in the Sebuk area.

Recent traces of elephant groups were not found in the Apan and Tampilon areas at the time of the surveys. However local informers had seen small groups in these locations about four months earlier. Indeed during previous surveys footprints of elephant groups were found at several locations along the lower Apan and lower Tampilon rivers.

The relatively low number of elephants encountered at the time of the surveys that could be identified with certainty does not indicate the total number of elephants. Small groups of elephants come through the Agison and Sibuda corridors all the time and after wandering for some weeks or longer move back to Sabah. Larger numbers of elephants but also larger groups are reported from many local informers from previous years.

It is assumed that nearly all of the female elephants give birth in the Kelabakan area in Sabah. This is the largest section of their home range with the largest area of preferred habitats. Group sizes are larger in Sabah and this means additional protection by other female elephants for vulnerable newly-born elephants.

Mating might occur in the Sebuk area. Local informants mention observations of male

elephants within elephant groups that they encountered years ago.

It was observed that the presence of solitary male elephants in the south follows certain seasons. Most of these elephants occur between November and April. It is possible that the elephant groups of females and their offspring follow the same seasonal patterns. This has not yet been confirmed as the elephant groups are always on the move and are found only in the most remote areas. Further research applying tracking techniques of individual elephants will provide more insight in this important issue. It should be realized however that whether the total number of elephants is small or large, it is the only population in Kalimantan and this population has been using their own unique routes and terrain knowledge for a very long time.

Conclusions and recommendations

By January 2012 all projected elephant surveys in Sebuku were completed, in the four upstream locations (Agison, Sibuda, Apan, Tampilon) as well as the southern locations.

Results of the surveys and subsequent data analyses include the following:

- All major food plants have been identified.
- The elephant habitat types were classified, with an assessment of importance to elephants;
- The overall elephant distribution, routes and movements in both western as well as eastern sections are now well known.
- The use and locations of salt licks is known.
- The corridors from Sabah into Sebuku and back are identified and evaluated: it is of major importance to realize that only two corridors are used (upper Agison and upper Sibuda) and that the eastern section has no corridors. This emphasizes the extreme importance of preserving these two corridors.
- Detailed mapping of the elephant tracks, including major river crossing points is now possible.
- Additional information on elephant behavior was obtained.
- The number of number of elephants present in the Sebuku at one time, even though this number is subject to seasonality and was at a low level during the time of the surveys.
- The sizes and composition of some typical elephant groups was found.

The development of the elephant management plan can now scientifically be based on detailed mapping of elephant habitats, elephant distribution and elephant tracks and routes. The major aspect of the management recommendations will be the designation of conservation zones or High Conservation Value Areas where no logging or transportation activities should be allowed. These are the corridors, the salt licks and the river sides of the Agison, Sibuda, Apan and Tampilon rivers up to 2 kilometers wide on both sides of the rivers.

In the other elephant habitats, reduced impact logging will be possible. The major food sources that need to be preserved are: all bamboo clumps, all *Arenga undulatifolia* palms, the small fields of *Blechnum orientale* ferns, and fruit trees, particularly *Artocarpus* species. Any of the logging activities should always take into consideration the presence of elephants. Especially elephant groups with juvenile and baby elephants are very sensitive to disturbances and logging and transportation activities in locations where elephant groups are wandering should be postponed until the elephants have moved on.

Trans-boundary collaboration with the stakeholders dealing with the same elephant populations and habitats in Sabah should be expanded.

The local community groups for elephant conflict mitigation that were formed by the local government should be supported.

Illegal logging particularly in elephant habitats should be dealt with through serious community development and law enforcement.

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Appendix 1 - The elephants of Borneo: the origin mystery

The elephants of Borneo are found only in the eastern part of Sabah and the adjacent northernmost part of East Kalimantan. No remnants from wild elephants have ever been found in any other part of Borneo. Fossil molars from Pleistocene elephants were found in the Niah caves in Sarawak, but it is not even sure whether these were originally from Borneo. Elephant bones excavated near Banjarmasin were most likely from an imported elephant kept at the court of the Sultan. (Cranbrook, Payne & Leh, 2008)

A Dutch military commander, Lt. Col. Habbema, based in East Kalimantan in the 1930's did an extensive survey on local elephant records by interviewing people throughout the area. He checked with many Punan, Kayan, Tidung, Bulungan and Kenyah people (including the most knowledgeable Kenyah historian at Long Nawang), but did not get a single historic record, memory or even myth about the presence of elephants in their areas.

The limited elephant distribution is very remarkable particularly since there is suitable habitat all over Borneo and the human population pressure is less than in Sumatra, where they have spread all over the island.

It has been the popular belief that the elephants were introduced to the east coast of Sabah by the sultan of Sulu, some 200-300 years ago. A few animals were released and have in the course of time established the current feral population.

In 2003 the results of DNA analysis of Borneo elephants were published in which it was demonstrated that the elephants from Borneo are genetically distinct and considerably different from elephants from Sumatra, Peninsular Malaysia and other mainland populations. This led to the conclusion that the elephants are native to Borneo and not a feral population (Fernando et al, 2003).

However, the results of the DNA analysis did not entirely exclude other possibilities. It is still possible that Borneo elephants are genetically similar to another population that was not included in the comparative analysis; either because samples were not available or because the samples do not exist anymore because the population has become extinct.

In 2008 a new hypothesis was published stating that the population of elephants of north-eastern Borneo consists of descendants from introduced individuals of the now extinct Java elephant. The elephants would then indeed have been transported to Borneo by the sultan of Sulu, as mentioned by several sources.

A record tells of a shipment of two elephants from the raja of Java given to the ruler of Sulu around 1395. The existence of wild-living herds of elephants on the island of Sulu (southern Philippines) was reported in the 18th century. The elephant population was however exterminated by the 19th century because they were too destructive to local crops and had no use anymore. (Cranbrook, Payne & Leh, 2008).

Another (indirect) record mentions that elephants were given as "a present from the Dutch East Indies company to the sultan of Sulu. The animals never reached Sulu but were released in Borneo because the sultan was afraid that the elephants would eat all available food of Sulu. They spread out after their release at Usang peninsula in NE Borneo" (van Balen, 1915).

There are many written records of domesticated elephants kept at royal courts in Java up to the 18th century, and elephants were transported for trade and as gifts throughout the archipelago. However, very little is known about the presence of wild elephants in Java, and there is no evidence that during the time that the elephants were sent to Sulu (supposedly around 1750) there were still wild population around.

Several archeological records of fossil elephant remains are known from Java. Just recently another fossilized elephant skeleton was discovered in Java. This elephant was estimated to have died some 200,000 years ago and is actually a different, more ancient species than the modern Asian elephant, *Elephas maximus*. (Nurfika Osman, 2009)

The only more recent specimen from around 1350 AD is from a site between Jakarta and Bantam (Cranbrook, Payne & Leh, 2008), and could well be from a domesticated elephant .

Perhaps the oldest marked records of elephant of Java are those on the Borobudur. Here we find carvings of elephants both living in the wild as well as domesticated. The highly correct representation of the elephant bodies could lead to the conclusion that the elephant was native to Java at the time the carvings were made. (Cammerloher, 1931).

Maclaine Campbell (1915) cites several early European natural-history records from Java.

One of the earliest records is from a traveler who visited Java in 1640 mentions that: " Java abounds both in wild and tame beasts; the forests are filled with elephants, rhinoceros, leopards, tigers, serpents, lizards, hogs without bristles." It is however not clear whether the traveler had seen elephants for himself or relied on secondary sources. There is no Dutch colonial record of wild elephant populations from Java (Veth, 1903). Further on, a record from 1823 mentions that " The forests of Java are inhabited by the rhinoceros, tiger, black tiger, leopard, tiger cat, boa-constrictor, and a variety of animals of milder natures. The elephant is not found in its wild state in these woods, though numerous in those of the neighbouring island."

The author himself writes:

"Quadrupeds. - As to useful or domestic quadrupeds, it may be mentioned that neither the elephant, the rhinoceros, nor the camel exists to-day in Java.

Elephant. - The first-named, however, was found until about 1650. It was of the Ceylon species and very small. At the time of the empire of Majapahit a number were kept in captivity, and were trained for carrying the maharajah on state occasions. Seeing that elephants are found in Sumatra at the present day in great numbers, there is nothing extraordinary in their having once been found in Java."

The question remains whether the elephants that were transported from Java to Sulu and than from Sulu to Borneo were from native wild stock, which probably had become extinct by that time. It is more likely that these animals were domesticated elephants from royal courts in Java. These elephants could have been brought in earlier from areas outside of Java, or could have been descendants of wild elephants from Java.

The fact still stands that the Borneo elephant was found to be a distinct sub-species. Whether these elephants are descendants from an extinct population, or from a still existing but unique population or the remnants of a native population, their conservation priorities remain the same.