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Smelling the monsoon: Senses and traditional weather forecasting knowledge among the *Kenyah Badeng* farmers of Sarawak, Malaysia

Gotzone Garay-Barayazarra* & Rajindra K Puri

Centre for Biocultural Diversity, University of Kent, Canterbury, UK CT2 7NR

E-mail: gotzonegarai@gmail.com

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The paper describes the rich variety of sensory knowledge associated with weather and climate prediction practices of *Kenyah Badeng* rice farmers in Sarawak, East Malaysia. Ethnobiological and ethnographic methods were used to document knowledge underpinning traditional forecasting techniques. This body of ethno-climatological knowledge includes the skilled use of bodily senses such as sight, sound, touch and smell to gather information on clouds, wind, temperature, humidity and rain needed to assess present and coming weather. This perceptual information is interpreted with a cultural storehouse of weather/climate-related categories and experiences, and plays an influential role in the scheduling of daily agricultural activities and responding to the threats of extreme climatic variability, such as that brought on by ENSO events every few years. The research demonstrates the importance of thinking of traditional knowledge in broad terms, as much more than the declarative knowledge of wordlists, stories and instructions. The means of engagement with the environment are beyond words, in the realm of embodied skills such as smelling the monsoon.

Keywords: Indigenous knowledge, Traditional forecasting, Climate forecasting, Sensory anthropology, Ethnoclimatology, Sarawak, East Malaysia, Borneo

IPC Int. Cl.⁸: G01W; G03C; AG2; G11

Among *Kenyah Badeng* rice farmers in tropical Sarawak, direct bodily senses, rather than the inanimate instruments and computer models of modern scientific forecasting, are the avenues through which people come to experience and therefore know and predict manifestations of their local weather. They interpret visual, aural and tactile perceptions of clouds, wind, temperature and rain with a cultural storehouse of climate-related categories and experiences when assessing the present and coming weather. Daily observations of weather are used to predict cloud cover, precipitation length and wind speed during the day, and precipitation length and strength during the night. Turning inwards, changes in the internal states of human bodies may also indicate coming changes in the weather, with warm but rainy days expected when people become irritable, lethargic and suffer insomnia. These observations influence the scheduling of daily agricultural activities, such as burning of swidden fields, planting, drying or threshing. Historically, *Badeng* weather forecasting was embedded in a rich and complex cosmological system that included ancestors, ghosts and a variety of

both helpful and dangerous spirits. Religious rites conducted by shaman-like leaders to seek spiritual favours included bird augury, planting ceremonies, fasting and animal sacrifices. The future of seasonal climate and human endeavours could be predicted by interpreting moon phases and the behaviour of birds, insects and other animals. The complex of *Kenyah Badeng* traditional knowledge and practices associated with weather and climate has been discussed through description of *Badeng* senses; analysis of the sensory knowledge underpinning traditional forecasting techniques; description of the *Kenyah Badeng* weather and climate classification systems; and introduction to related *Kenyah Badeng* subsistence activities that are affected by forecasting knowledge and practices. Since traditional knowledge is embodied in skills and performance, therefore it is difficult to know of without engaging with people as they engage with their environments. Yet, it is vital if we are to understand how and why people do what they do with regard to the weather and weather forecasts.

Methodology

The primary data presented here was collected by Garay-Barayazarra during 16 months of ethnographic

*Corresponding author

fieldwork, between May 2008 and August 2009, in Data Kakus, the largest Kenyah Badeng village in Sarawak, East Malaysia. Additional information is drawn from other long-term research data with distantly related *Kenyah Badeng* in East Kalimantan Indonesia¹. Data Kakus (2°39'10"N 113°37'18"E) is located inland from the coastal city of Bintulu, in rolling hills of mostly secondary forest, oil palm plantations and villages of indigenous permanent and semi-permanent rice cultivators. With 99% of the community's approximately 2,000 residents Borneo Evangelical Mission followers, the *Kenyah Badeng* of Data Kakus generally spend their weekdays in their rice fields outside the village but return to Data Kakus for the weekend in order to attend church services, family duties and social events. The primary occupation of *Kenyah Badeng* villagers is rice swidden farming and gardening, although their current necessity for cash is fulfilled by engaging in activities such as cultivating cash crops, working on oil palm plantations, making and selling handcrafts and running small scale retail businesses. Data Kakus experiences an equatorial climatic regime, with high temperatures and high rainfall typical of tropical forest areas. However, rainfall is markedly seasonal as this northern coast of Borneo is subject to the annual shift of the SW monsoon, between August and February. Also, the whole island is subject to the ENSO, resulting in an interannual cycle of extreme weather, oscillating between either long droughts (caused by *El Niño* events that often lead to extensive forest fires) or months of heavy rainfall and flooding (caused by *La Niña* events). ENSO events have played an important role in the history of *Badeng* settlement patterns^{2,3}. In 1977, some *Badeng* from Long Busang visited the hospital in Kapit and were not able to return home due to low river levels that made travel upstream impossible. They stayed with the *Sepakang* community in Long Dungan, and after a long waiting period, were able to buy land from them. By 1980, the majority of the *Kenyah Badeng* of Long Busang (around 1,800 people) had moved downriver to Long Dungan. These *Badeng* are the ones that inhabit Data Kakus today.

In the last 40 years, ENSO events appear to be both more frequent and more intense⁴. Some scholars have described how *Kenyah Badeng* and *Penan Benalui* respond to such events, and suggested that while not labelled as such, local knowledge systems concerned with weather and climate do demonstrate recognition

of interannual variation and its consequences, such as prolonged drought or flooding⁵. These ideas have been developed further elucidating the complexities of local classification systems for daily, seasonal and annual variation in weather and climate, and describe how the Kenyah understand and live with these multi-scaled phenomena. Concerns have been shown with the processes of perception, the senses used to detect changes in locally relevant variables, and the processes of classification, interpretation, forecasting and response that follow on from sensory perception. Use of ethnographic methods continues to be essential for capturing the full set of lived experiences and cultural meanings associated with weather and climate⁶. The value of in-depth research based on nonrandom, small-sized samples has been highlighted; open-ended interviews, and face-to-face engagement of research participants that characterize ethnographic approaches, quick studies based on surveys or rapid rural appraisal (RRA) methods, will never get beyond the superficial in local knowledge of environmental features. In some applied research, a thick description of local knowledge is not necessary, but certainly any attempt to document and understand the tacit types of understanding that are used in weather forecasting may require more investment in time and effort in ethnographic methods⁷.

The following questions and methods guided the research in Data Kakus: How do Kenyah Badeng perceive and classify weather and its variability? How do they predict or forecast weather events? To what extent are non visual indicators important in predicting the weather? To what extent are traditional practices still used, such as bird augury? How do people respond to daily weather events, and extreme events, especially those that appear to be consequences of ENSO? Informal interviews and participant observation were used as an entry point into people's perceptions of weather and climate variation. It is fairly straightforward to start a conversation about the weather, it being an 'icebreaker' topic in many cultures⁸. Freelists can be used to collect names of kinds of weather (rain, wind, cloud) and seasons (dry and wet). However, climate is not a concept or knowledge domain that the Kenyah recognize. Other analytical tools such as pile sorting, ranking, and triads, were used to document how *Kenyah Badeng* distinguish many different types of clouds, rains, winds, and other phenomena. In the process of eliciting these domains, basic principles

underlying cultural notions of weather and climate were revealed. Also, local understandings of what we think of as climatic variability could be interpreted due to the existence of categories of extreme weather, such as long droughts or big rains. Question frames using 'What if ___ ' create hypothetical scenarios, which are very effective at eliciting expected responses to varying types of expected and extreme weather events. They can also be used to prompt questions about the consequences of past events. Oral histories of families and communities were recorded, which provided information on fluctuating weather conditions, wildlife behaviour, and other natural phenomena that help orient people's movements over the territory. Story telling still remains a popular past time in communities across Borneo, and oral histories an important story form for transmitting cultural knowledge across generations. We also used interactive visual methods, such as historical paintings, photographs of varying skies and weather conditions, and other documents, to elicit local categories and people's stories and commentaries about weather events and their relationship to changes in the surrounding landscape.

Seasonal calendars were constructed in the course of interviews with key informants to further develop an understanding of temporal classification, including the relationship of seasonal weather to natural phenomena (forest phenology) and human activities (swidden cycle). People were asked either to name the parts of a year, or to start at one point and to list the parts. Observations and interviews over the course of the fieldwork produced the information to fill in the details of this calendar, and thus ground truth, or verify the initial schema. Without the time to verify them, seasonal calendars, need to be treated with caution, as conceptual models rather than as factual representations of climate-related events and activities⁹. These calendars were used to clarify local conceptions of temporal order and to discuss past responses to normal and extreme seasonal and interannual variability. Finally, simple open-ended interviews and focus groups with elders and local experts were used to elicit shared and specialized knowledge about past rituals that were used to make predictions about the weather or the outcomes of human endeavours¹⁰⁻¹⁴. The preliminary results for some of these questions, with a focus on the use of the senses in identifying and predicting the weather are presented¹⁵.

Results and discussion

In contrast with Western societies, where the proliferation of visual imagery in modernity has promoted the notion that the world is, above all, something to see; *Badeng* society could be better fitted within the oral or non-writing cultures^{16,17}. These tend to project reality in comprehensive auditory terms, such as voice and harmony. Their understanding of the world is described as less static and more dynamic as well as relatively unpredictable. This dominant medium of communication does not mean that their perception of creation and life is mainly animated by sound. *Badeng* society's rich diversity of sensory symbolism observed in their predicting techniques, agricultural practices and language reveals that each area of sense helps in the construction of their symbolic organization. Previously, *Kenyah Badeng* based their predictions on many natural, cultural and social phenomena, interpreted through a religious framework of deities, nature spirits, and omen birds. Ignoring omen birds could result in accidents and misfortune. Weather was also seen as a moral response to the activities and behaviours of humans: trespass in cemeteries, disrespect of the dead and mockery of animals were believed to lead to violent thunderstorms and heavy rain¹⁸. Today, the traditional forecasting system based on omens is but a distant memory, denigrated and relegated to the pre-Christian past. However, neither do they make use of Western scientific forecasting systems available through public institutions nor the media, despite a weather station in the nearby trading town of Belaga. Owned by the Drainage and Irrigation Systems (DID), the daily collected weather data is not available to the public. Information from other weather stations reaches the village only sporadically, and it mainly brings late news from coastal areas. Instead, *Badeng* people rely on traditional daily sensations of the environment as well as their own feelings. First though, let's examine *Badeng* understandings of their senses.

Kenyah Badeng culture of senses

Anthropological research on senses and knowledge has shown that sensory perception is a cultural as well as a physical act that is the senses are conditioned by cultural values, beliefs and ways of being that influence how sense are interpreted. Example of the durian fruit (*Durio* sp), much loved by the *Kenyah Badeng* and indeed most people in Southeast Asia has

been given, 'if one considers the radical difference between most Southeast Asians' enthusiastic response to the smell of the durian fruit in contrast to the disgust it evokes from most Europeans, it becomes immediately apparent that smell is as culturally relative as aesthetic judgment¹⁹. To the extent that cultures vary, then the senses vary as well, such that they too may be seen to represent groups of people, and thus serve to create and maintain social boundaries. So, sight, hearing, touch, taste, and smell are not only means of apprehending physical phenomena but are also avenues for the transmission of cultural values¹⁹⁻²¹.

Similar to Western customary classification, the *Badeng* enumerate five senses: *Na'at* 'to see'; *ten* 'to taste', *nyemagap* 'to touch', *ngening* 'to hear' and *madek* 'to smell'. As in many Malay dialects, it's common to express senses in the passive, as in 'it smells of ... ' or 'it tastes of ... '; so many of these verbs may be rarely used in everyday speech. For example, *ba'u madam* (literally, 'smell rotten' or 'it smells rotten to me'). Sensory verbs are often implied and thus dropped in everyday statements, such as, *boka sa'ai ngojau, kelok ojan*. ('if [we hear] the frog croak, then it will rain'). One curious colloquialism among the *Badeng* of Data Kakus is the use of *ngening* 'to hear' to refer to smell as in *ngening tega ba'u* 'to smell something that emits a good aroma'. Such intermingling of sensory experience informs not only the aesthetic appreciation of the environment, but also the organization of *Badeng* senses.

Like among other forest dependent populations in Southeast Asia and the Pacific, the multiple levels of meaning the *Badeng* project onto and detect in the sounds of their environment reflect the extent to which hearing is a salient cognitive and functional domain for them²². Bird sounds, for example, do not only reckon space or distance, but also time and the weather. This is the case of the *bitucit* bird, whose call once marked the time when the farmers should return from their fields in order to beat the arrival of the afternoon showers. Still today, the *Badeng* privilege the aural over the visual in their ceremonial as well as in their everyday life; although, this is being increasingly mixed with visualized representations at present. For instance, gasoline-powered generators, a symbol of economic prosperity, are now used to light evening ceremonies when darkness had a priority role before. During the *ramai o'o ajau*, men dress and dance at night evoking the warrior image of a hornbill

bird alert in the dark forest. Before, these ceremonies were held in the darkness of the longhouse lit only by firelight. As in the dark forest, it was hearing, not vision what was the dominant sensory mode. While the audience was aware of the motion, colour and mimicking gestures of the dancer, the nuances of meaning lay in the sound of improvised shouts and foot stomping, the instrumental pulse of *sapehs* (Kenyah-Kayan guitars) and bodily motions. This orchestration of the senses had the effect of moving the whole audience from alert to shock at unexpected moments. But while the sense of hearing might seem emphasized in *Badeng* culture, the senses are not segregated. Hearing is intimately related with sight and also with smell. The *Badeng* experience of the dense sensuality of evening darkness in the daily life of the longhouses, with voices overlapping the misting light rains and insects and frogs of the nearby bush is sensually continuous with the smoky aromas that fires and kerosene lamps release into the longhouse and diffuse out into the ever moist night air.

Kenyah *Badeng* daily observations

During the day, *Badeng* weather observations include the interpretation of animal behaviour, sky coverage, precipitation length and wind speed; at night they attend to precipitation length and strength as well as the interpretation of star formations. Even if *Badeng* farmers are not talking about weather or manifesting conscious patterns of weather behaviour, it is possible to observe how they are aware of it, monitoring it with multiple senses, and processing the possible changes they will make in their farming activities in accordance with perceived changes. Some of the most popular indicators of rain based on animal behaviour include the unmistakable noise of chickens crowing under the longhouses and frogs croaking near the riverside when showers are approaching. The appearance of increasing numbers of geckos on the walls and ceilings as well as the emergence of fish swimming near the surface of ponds alert farmers to coming rains (Fig. 1). Also, flies biting more viciously than usual make this upcoming event uncomfortable but predictable. For farmers, the end of precipitation is as important as its approach. Rain will stop in a relatively short period of time (between the next 20 and 40 minutes) once sparrows start flying faster again. Also, swallows flying low near the rice fields indicate to farmers the right time to go back to their fields despite the appearance of unstoppable

rains (Fig. 2). Animal behaviour helps farmers predict droughts as well. The theory that noisy leafhoppers (*Cicadellidae*) announce dry times is widely believed among farming communities of Sarawak and Sabah (Fig. 3). Entomologists argue that three reasons support the theory: warmer temperatures mean that insects can complete their life cycles faster, resulting in some spectacular population explosion from one week to the next; rain is a limiting factor for these creatures since it can wash them off plant surfaces; and fungal pathogens that attack insects under humid conditions are adversely affected by dry weather²³. Together with the noise of leafhoppers, the increased presence of the *pau long*, Great green bush cricket (*Tettigonia viridissima*) was identified as an indicator of prolonged droughts and possible crop failures due to infestation (Fig. 4)

Historical weather patterns greatly help *Badeng* farmers to predict when and how it will rain next. This is possible by revising the latest precipitation schema—this is when, where and how often it rained the last time. Dry rice farmers need sunlight as much as they need rain in order to be successful in their harvests. It is important for them to receive the highest quantity of water between October and December and the lowest between March and August. Following this criteria, *Badeng* people pay attention to the number of days that it rains per week, and expect a correlation of three dry days for one of rain between April and June, and three days of rain for a dry day between October and December. Persistent differences in these temporal correlations indicate short or long-term weather variation. *Kenyah Badeng* also pay attention to changing personal moods and feelings. They understand that predictions are not only based on historical weather data, but also on intuition (knowledge based on feelings derived from accumulated experiences). In this sense, they keep track of personal symptoms such as tiredness, pain or smells as well as changes in their eating, drinking or sleeping habits. Some situations like extremely hot or cold temperatures, changes in barometric pressure or humidity and wind trigger *Badeng* physical conditions. For example, barometric pressure headache was found common among children under 14 yrs old in the village boarding school. Migraines were more likely when there was low pressure, the passage of a warm front and high temperature and humidity were rising. The *Badeng* also complain about low back pain when a storm front is moving in;

and refer to breathing problems when low clouds (*stratus*) last longer than usual. Also, high levels of humidity are predicted when people suffer sleepiness and when they feel irritable, depressed and show a lack of vigour. These feelings are often expressed by the concept of *leko*. For example, *leko t'nao* means feeling heavy, or tired, to go to work, or *leko pisu*, which means feeling without desire to talk.

Among the *Badeng*, mixed groups of sensory energies order space and time and govern particular manifestations of weather. For example, they make special use of visual characteristics when observing clouds; however, these will be mixed with tactile or smell senses when referring to winds, and with the senses of taste and hearing when addressing precipitation. The dry and subsiding winds in May bring back the smell of the Southwest monsoon to rural areas of the interior of Sarawak. Previous Southwest winds have led to numerous reports of a strong forest-like scent that includes the smell of wild animals (dirty animals, as they point out), scented fish-ponds and an 'earthy' smell in the air, probably caused by micro-organisms in the soil. Between May and September these expected rain showers move inland with the sea breeze and often develop into thunderstorms later in the afternoon²⁴. When *Badeng* people feel warm winds on their skin they are made aware of a drought period they are still to face. On the other hand, the lack of winds during the day alerts them of night and morning showers to come. Hearing also helps them to monitor upcoming showers. When sky coverage, wind and temperature suggest rainy conditions, *Badeng* farmers estimate a 30 minute interval from the first heard thunderstorm to the first drops, and a one hour interval from the first heard thunderstorm to the approach of heavy rains. Some *Badeng* have also reported feeling thirsty before storms arrive. This might be due to a loss of water and salts during the high temperatures that characterize the arrival of afternoon showers.

Historically, these *Badeng* indicators and resulting practices were embedded in a rich and complex cosmological system that included omens, planting ceremonies, animal sacrifices and a complex set of spirits. Also, they used a variety of means of forecasting the future (personal and climatic), which included the interpretation of star formations, solar calendars, moon-phases, and the behaviour of birds, insects and other animals. For example, although not practiced anymore, the elders in Data Kakus very well

remember the *tungan taup* (Fig.6) forecasting system by which the village weatherman and protector, *da malan*, used to predict droughts and manipulate the weather. *Da malan* lived separated from the rest of the community, where he executed weather rituals and worshiped the goddess *Bungan* and the spirits. He was in charge of the farming calendar and kept track of droughts and rains by measuring the sun's path throughout the year. A set of wood-sticks and platforms helped him in the process. By mid-August, when the sun reached its highest point, the shadow was measured following a ritualistic process of meticulous transportation of the sticks to the elders' assembly point for further comparison and discussion. The final decision allowed *da malan*, together with the elders, to predict when to burn new swiddens and when to sow the new seed. This process marked the beginning of the new harvesting year. Puri confirms that this practice was still in use by the *Kenyah Badeng* of Long Peliran (East Kalimantan) in 1990--93⁵. Today, although there is evidence of individual use among some elders of the Data Kakus community, burning schedules follow western calendars and are coordinated by village chiefs at a district level.

Kenyah Badeng classificatory system

Observations and other sensations of the weather, internal feelings, and all the other indicators already described, identify a set of categories of weather and season that then trigger beliefs and practices that affect everyday behaviour and planning for the future. In many cases, interpretation of the various signs, sometime contradictory, would be left to the local weatherman (*da malan*) and other respected elders, and consequent behaviour, agricultural or other, coordinated by the community. Still, all farmers have some scope for independent decisions based on their own interpretation of exiting conditions. Understanding local classificatory systems is thus essential for linking indicators with human responses. The folk taxonomy of climate can be as complex as any other folk taxonomy, presenting many levels, covert categories, polysemy and other characteristics uncovered by ethnobiologists for other classificatory domains^{5,25}. The study sustains this theory. In Borneo, the *Badeng* appear to recognize four levels in their classificatory system for climate: the generic level of annual shifts in climate equivalent to our seasons (*musim*); a sub-generic level of more short-term climatic stabilities or sub-seasonal occurrences associated with

storms and spells; a finer level of climatic stability associated with daily variation in cloud, sun, wind and rain; and a super-ordinate level associated with longer-term stabilities, such as ENSO events, though these are not labelled as such in those societies examined so far.

The *Badeng*, endowed with an inherent curiosity, observe and categorize clouds, winds and rain based on their physical, temporal and spatial characteristics. Clouds vary depending on their shape (*buding* 'dots', *lia buki* 'ginger shape'), colour (*putih* 'white', *bala* 'red', *saleng* 'black'), and size (*iut* 'small', *biu* 'big'); also cloud names will depend on the location of the cloud from the speaker (*abun ke cok* 'far away cloud', *nyan ale* 'very close cloud'), the distance between the clouds (*dua ke lo'ong* 'two clouds close to each other in the middle of the blue sky', *abun pasi* 'many separated dots in the sky') or the location of the cloud in the sky (*abun penyot* 'low cloud', *abun ke liok* 'several clouds up and down'). Finally, clouds vary depending on the time they appear (*abun mompam* 'morning clouds', *abun lepa ojan* 'after rain clouds', *abun pekau tungan* 'the clouds found very early in the morning, when people go to plant rice to their fields'). The amount of clouds will reveal the sky coverage (*abun pelaya* 'half cloudy-half blue sky', *mabun* 'fully covered', *langit lua* 'naked sky, no clouds'). *Badeng* people also pay attention to physical, temporal and spatial characteristics when referring to rain. *Ojan pa 'ang tau*, for example, means that it rains while the sun is up (this rain will not last long); *ojan ema* refers to a light but non-stopping rain; and *ojan pa 'abi taup* means that strong rains have been persistent all day long. They also keep track of the location of the rain (rain in the hamlet of Nyolau means rain in Data Kakus, but rain in Data Kakus does not mean rain in Nyolau), the intensity of the rain (*ojan kasa* 'strong but short-term rain', *ojan ema* 'weak but long-term rain') and the timing (a morning rain that does not stop by 7.30 am will not stop till 10.30 am or will not stop at all). An interesting type of rain is the so called *ojan babui* 'wild-pig rain' or *ojan dok* 'monkey rain'. This refers to strong long-term rains, where it is understood that only wild pigs and monkeys will be in the rice fields taking advantage of the farmer's absence.

Wind observations form an important part of the scheduling of *Badeng* subsistence activities; hence they also pay attention to the wind speed, strength and direction in order to predict sky coverage and

precipitation. For example, *bayu kasa* 'strong winds' help them separate the grain from the husk avoiding extra physical efforts (Fig.5). Also, swiddens are always burned at high noon, when it is hottest and when strong updrafts carry fires lit at the bottom of

slopes upward at very fast pace. Some winds (such as *bayu kerit* 'light wind' and *bayu kasa* are greatly appreciated for cooling purposes, making working or travelling preferable. However, stronger winds (such as *layam kasa* 'strong wind' and *asin iang*



Figs.1-6 Fishes swimming at the surface of ponds located next to the long houses alert farmers of coming rains, 2 Swallows flying low over the rice fields advice farmers of the end of precipitation despite the appearance of prolonged rains, 3 Leafhopper (*Cicadellidae*), 4 Grasshopper (*Tettigonia viridissima*), 5 a Kenyah Badeng woman from Sarawak (Malaysia) taking advantage of the strength of the wind in order to separate the grain from the husk, 6 Oko Balan, a Kenyah Baden man from East Kalimantan (Indonesia) practicing the Kenyah Badeng "*tungan taup*" weather forecasting system

'cyclone') keep them alert and prevent them for hunting and gathering in the forest. The *Badeng* recognize two general seasons: *musim taga* (drought or dry season) and *musim ojan* (rain or wet season). The dry season lasts from March to August, and the beginning is marked by a larger number of consecutive dry days. Long periods of dryness at the early stage of the dry season (February and March) put *Badeng* on alert for possible wet Augusts that might hamper their burning tasks. The wet season, from September to February, is characterized by the completion of fewer farming duties and more social events (such as visiting family members in the coastal areas or working on handcrafts in the longhouse verandas). From a more utilitarian view of seasons, in which the *Badeng* observe and categorize them because they have distinct uses or consequences (they influence food, clothing, medicines, building materials and the like, or they can be harmful, dangerous or annoying), the *Badeng* speak of sub-seasons such as the *buah* 'fruit' season, the *bayu* 'windy' season, and the *nyara* 'tired' seasons²⁶. Although the *Badeng* do not appear to have a category corresponding to an ENSO year, their discussions and actions suggest they do indeed recognize that dry seasons can vary from year to year and that some year's floods and fires can be particularly destructive. It has also been possible to observe how they recognize long-term variability in climate based on the periodic occurrence of mastfruiting explosions and pig migrations.

***Kenyah Badeng* practices**

A different way to observe the traditional weather and climate knowledge of *Badeng* communities is through their practices. The climate related knowledge is embedded in peoples' behaviours^{5,7,27,28}. The *Badeng* case is not an exception. As we conclude, *Kenyah Badeng* understanding of seasonal weather may not be explicit in their classificatory systems for weather and climate but it can be deduced from observing their activities. The *Badeng* measure time in relation to a series of temporal points related to rice planting phases: slashing, burning, seeding, weeding, and harvesting. All of these occur in accordance with particular phases and weather conditions of the seasonal calendar, and any changes in weather conditions will delay or hamper the completion of the agricultural cycle, with potentially disastrous results for the farmers. The most significant activity that marks the end/start of the farming calendar is the *ramai o'o ajau*, 'post-harvest festival'. When the

headman, or weatherman, of the village decides that the dry season has reached its middle point, he invites the villagers to celebrate the end of the farming season. This ritual closes one farming cycle, and creates the opportunity for people to decide where to establish their next swidden fields. This farming calendar was strictly followed in the past, when the Western concept of 'year' was non-existent, and the relative age of an individual was related to the *da malan* at the time when the baby was born. It is interesting to note that later on, the *Kenyah Badeng* adopted the term *oman* 'to eat' to mean 'year'.

There are other observable practices which indicate local understandings of weather and its prediction. If a *Badeng* woman expects rains in the next 12 hrs, she will burn and plant new seeds in the garden (avoiding predators), or will collect forest and garden products to bring to the market the day after (when the bad weather may halt her farming tasks). If rains are expected in the next hour, clothes and plant products, such as seeds, left drying in the sun will suddenly vanish, as will the usual collection of old men and women foraging around the village grounds for firewood, fruits and vegetables. During day or night church services, it is also interesting to observe the increasing number of umbrellas that people leave at the entrance when rains are expected within a couple of hours. It appears that *Badeng* men pay more attention to weekly forecasts than to 24-hour observations. If they predict three to six days of no rain, they will begin construction or reparation tasks, leaving for the moment their farming duties. Concerning dry days, *Kenyah* women will opt to clean oversize materials, such as sheets, mosquito nets, or blankets if blue sky is predicted in the next 12 hrs; if no rain is expected in the next half an hour or more, they will set out rattan mats to dry rice or pepper seeds. Both men and women concerned with their health will bring extra amounts of water and extra clothing to the field if the sun is expected to be stronger than usual.

Conclusion

While western people seem to have the idea that nature is something that they go 'to look at' but 'don't touch', the *Kenyah Badeng* like and expect to get involved with their natural environment. They like touching and smelling the forest, they know there is a time to work in the mud and a time to feel the cold water running down their necks; they enjoy discussing

the frosty mornings and windy afternoons while taking a bath in the river; and look forward to the home fires that will warm and perfume their huts with scented wood, warm fresh rice and aromatic herbs. It is this involvement and embodiment that comes prior to any objectification that may take place as the *Badeng* s best tool to understand and predict weather conditions. Today, the number of *Badeng* following traditional beliefs and practices has decreased dramatically. Yet, and surprisingly given the availability of science based forecasts in the media, they still make use of a complex, multi-sensorial systems of indicators for daily weather forecasting. Their system of weather perceptions serves as a farmers' almanac of advice that helps them anticipate changing conditions and potentially high-risk situations. It helps people decide what to wear, whether to travel, and when and how they should tend gardens and fields at different times of the year. While the ability to predict future seasonal changes, like those associated with ENSO events, may be lost altogether, the *Badeng* still appear to be able to anticipate and respond to many of the consequences associated with extreme climatic variability. As we have shown, this traditional knowledge is embodied in skills and performances often occurring as people go about their daily activities; sensing as they move through and engage with their environment. Participant observation is still the only way to discover how people truly engage with their environment on a moment-by-moment basis, using all of their senses and reacting almost instantaneously to rising contingencies. A closer engagement with farmers as they go about their everyday activities is vital if we are to understand how and why people do what they do with regard to the weather and weather forecasts.

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