

# RESEARCH OF ENVIRONMENTAL ADAPTATION OF TRADITIONAL BUILDING CONSTRUCTIONS AND TECHNIQUES IN NIAS

P. Gruber <sup>a</sup>, U. Herbig <sup>b</sup>

<sup>a</sup>Vienna University of Technology, Institute of Architecture and Design, Department of Building Construction (HB 2),  
petra@hotpen.com

<sup>b</sup>Institute for Comparative Research in Architecture, uh@iva-icra.org

**KEY WORDS:** Interdisciplinary, building survey, Earthquake resistant architecture, adaptive structures, vernacular architecture

**ABSTRACT:** On December 26<sup>th</sup> 2004 a major earthquake caused a Tsunami in the region of the Indian Ocean. The epicentre of the quake lay offshore the Indonesian Island of Sumatra close to its neighbouring island Nias. 3 months later Nias was again hit by a series of earthquakes causing death of thousands of people.

Besides the human tragedy the earthquake the natural disasters showed that outstanding resilience of the vernacular buildings: whereas 80 percent of the modern style houses collapsed few old buildings were damaged, causing less harm to the inhabitants.

The traditional architecture of the Island of Nias is an outstanding example of the adaptation to specific environmental conditions. The location of the settlements, used materials, building construction and techniques result from development over centuries. The houses provide excellent shelter from the hot and humid tropical climate. In particular they seem to be constructed specifically to withstand the common unstable ground conditions and earthquakes in the area.

During the earthquakes in the last months the exceptional stability of the traditional constructions has been proved. Even though, the knowledge and application of these techniques is endangered due to different reasons.

Scientists of the Viennese Institute for Comparative Research in Architecture undertook an interdisciplinary excursion to Nias in summer 2003. A 45 minutes documentary film summarized the results of the field trip. The building surveys gained in 2003 and results of ongoing interdisciplinary and international cooperation with a wide range of experts and local organisations provided a basis for the research project, which will finally lead to the sustainable development of earth quake resistant architecture in Nias for the 21st century considering indigenous principles, knowledge and techniques.

## INTRODUCTION

Nias, is a small island 120 kilometres west offshore the Indonesian archipelago of Sumatra. Until recently it has been renowned as a perfect surf spot only to a small group of people.

In the aftermath of the Tsunami, on the 28<sup>th</sup> of March 2005 Nias was struck by a severe earthquake, which destroyed numerous buildings. Thousands of people lost their lives in the collapsing houses. Only these recent natural disasters made the island known to the general public.

Nias is part of a very active tectonic area. Lying on the fracture zone of the so called Eurasian and Indo-Australian tectonic plates it is shaken by earthquakes regularly causing the inhabitants to call Nias "the dancing island".

Significantly most of the destroyed buildings have been built out of concrete within the recent decades following western influence, but not meeting western standards concerning foundation and safety. In contrast comparatively few vernacular houses collapsed or were damaged by the quake. In the indigenous architecture of Nias over many generations special constructions have been developed to make buildings resistant to earthquakes. Particularly interesting are the foundations and the elevation with unique and complex arrangement of vertical and diagonal columns. If the buildings are well maintained they can last over generations and withstand even strong seismic shocks. Even if damage occurs the threat to life is not as dangerous due to the relative lightness of the wooden constructions.

Although the vernacular architectural of Nias has undoubted advantages the people prefer to build bungalow style buildings made of concrete following modern influences. The recent catastrophe may start a process of reconsideration of the traditional ways of building. Research of the indigenous building types has to be carried out in order to apply the

findings to the design of new forms, constructions and typologies.

The Vienna based Institute for Comparative Research in Architecture (ICRA) started to work on a documentation of the traditional building methods of Indonesia in 2003. A first outcome of the research has been published as a documentary film, which was finished by the time the Tsunami hit the region. Our first reaction was to use the presentation of the preview to collect donations for the victims.

Furthermore the building surveys will provide a basis for comprehensive analysis of the traditional buildings in Nias. In interdisciplinary cooperation with Indonesian scientists and in consideration of the indigenous construction principles, knowledge and techniques, a proposal for future earth quake resistant architectural developments will be worked out.

## 1. INDIGENOUS ARCHITECTURE OF NIAS

"Tano Niha" land of mankind is what the people of Nias are calling their homeland. In ancient days head hunting, ancestor worship, feasts of merit and a stratified society composed on noble men, commoners and slaves shaped the living of the small island.

In former days Nias was a wild place, overgrown with jungle, with only few settlements situated inside the island far from the coast. Today there are many settlements along the shoreline, and you can find large plantations on the island. Only few is left from the original forest and good building timber is becoming scarce. Nowadays visitors of the populated country can hardly imagine that old travel stories describe Nias as an uninhabited island.

1500 years ago settlers from Southeast Asia started to populate the island from its centre. Due to the rough topography most of the settlements were erected inland, in the most southern and

most northern parts of the island. The territories were isolated and developed independently. Differences in social organisation and village formation divide Nias into three distinct regions: north, central and south. Between the regions you will find linguistic, social and cultural differences, as well as diversities in architecture.

### 1.1 Architecture of North Nias

Traditional villages in the northern part of consist either of groups of 6 to 12 oval houses, which are being oriented longitudinal-side towards the street or single cottages far away from each other, also in oval shape.

In former times the settlements were fortified with fences of bamboo or with an earth walls overgrown with trees.



Fig. 1: A Settlement in North Nias

In front of the houses traditionally megaliths are placed. These stones symbolize the connection between the living and the dead. They reflect the social status of the house owner. Nias is famous for its megalith culture, culminating in the elaborate pieces of South Nias.

The houses were entered from the village square, through a bottom flap underneath the house. A staircase has replaced this entrance or a front porch as this defensive preparation is not needed any longer.

The steeply pitched roofs are a notable feature of Nias houses. Still most of them are covered with palm leaves although the use of tin is getting more popular. In North Nias it is a light construction with an unobstructed roof space, which provides upper storage room above the main living floor. Skylight windows allow the daylight to enter the interior of the building and encourage the circulation of air.

This kind of opening is peculiar to the island of Nias and cannot be found elsewhere in the Archipelago.



Fig. 2: Skylight windows of a Nias house

The interior of the North Nias house is surprisingly light. Besides the skylights in the roof, large openings with louvers provide the main source of daylight illumination and ventilation. The louvers and the vast roof space enforce the air circulation in the house, providing a comfortable climate within the building. The living floor is divided into a meeting room, "Talu salo" and a variable number of bedrooms. The kitchen and sanitary rooms are situated in an annex on the backside of the house.

The house is hardly furnished, the inhabitants belongings stored in chests. The most important piece of furniture is a long plank below the louvers, which the tenants use as a bench. From there they overlook the village square and get easily into contact with the people on the street and in other houses. Considering an average of 250 days of rain per year, these views options, together with the big meeting room, enable essential social contact.



Fig. 3: Light interior

The whole building though oval in floor plan, is elevated onto an orthogonal substructure of several rows of pillars and numerous diagonal posts. To maximize the elasticity of the construction the pillars are not settled in the ground but rest on top of stone foundations. This detail is a very common constructive wood protection avoiding the direct contact between wood and earth to make the construction more durable.



Fig. 4: Foundation of a building in North Nias

### 1.2 Architecture of Central Nias

Although the settlement history of Nias has its roots in Central Nias nowadays the architecture of this region appears as a hybrid of northern and southern styles. Like in the villages of North Nias the settlements are a collective of single buildings. But different from the north the houses are situated with its eaves facing the village square. This orientation and the rectangular floor plan are also found in the South Nias villages.



Fig. 5: House in Central Nias

Characteristic features of the architecture especially in Central Nias are decoration and ornamental art. At the fronts samples and animal representations serve as protection for the house and its inhabitants. Other symbols inform about the conditions of the family regarding fertility, for example the number of women living in the house.

The hybrid typology of the Central Nias houses has not yet been fully examined. Research on its origin and influences on North- and South Nias types will form an important part of our project.



Fig. 6: Decoration in Central Nias

### 1.3 Architecture of South Nias

Villages in South Nias are situated on hills and are named after their location. In the past, when warfare and headhunting raids were endemic, an outer palisade of sharpened bamboo stakes fortified the village with a deep ditch behind.



Fig. 7: Settlement in South Nias

The settlements can consist of several hundred dwellings arranged on either side of paved street, which may be up to 100 meters long. Due to the elevated sites grand stone staircases

form the beginnings of the streets. The basic linear street pattern can be enlarged to T- or L shaped configuration.

In the covered area in front of the houses along the street semi-public space is used for working, socialising and for transition. A drainage gutter defines the border. The following area towards the street is reserved for the megaliths as representation space. This zone is called "wall of stones" (*öli batu*) and indicates the rank of the householders. The megaliths are a kind of petrified model of the social hierarchy and feasts of merit. The stones are classified by gender, and come in a variety of forms, which include menhirs, benches and circular seats.



Fig. 8: Nias hosts an important megalith culture

The house of the chief is usually the largest structure and is located at the centre of the village. Besides used to be a meeting house, called bale.

The standard typology of the South Nias house is a rectangular shaped elevated row house construction oriented with the eaves towards the street. The substructure is made of 4 rows of strong pillars (Ehomo), reaching from ground to first level. Diagonal posts like in North-Nias houses support them. But on the contrary to this typology here the v-shaped columns are situated at the very front, acting as support and as representative element. Again, all house posts rest on foundation stones on one hand to prevent them from rotting and on the other hand to make the construction as a whole more flexible. The space created beneath the house is used for storage and as a stable.



Fig. 9: Facade in South Nias

Between two coupled houses covered entrance terraces are shared by pairs of adjacent households. Neighbouring houses are also connected with doors to provide escape routes, which were needed in the past.

A central fireplace divides the interior space into a public room in front and sleeping rooms in the back. The front room is lighted by an opening, which is stretching over the whole street facade and is secured by a wooden grid. Like in the north the

furniture is sparse. Constructive elements of the cantilevered front facade create different floor levels in the interior space, being used as benches and for storage purposes.



Fig. 10: Interior

The steeply pitched roofs are constructed with a set of inclined rafters, supported by roof beams and numerous horizontal and vertical elements on different levels. Though light the construction is very coherent and stable against seismic movements. Like in North Nias skylight windows provide extra light and ventilation. In former times they also had the function of an emergency exit.

Decorative elements at the interior show an advanced craftsmanship. Elaborate and detailed carvings at the pillars may show arms to welcome guests and fertility symbols.

## 2. THE PROJECT

### 2.1 Partners

Important premises of the project are the integration into regional efforts and interdisciplinary approach. Pater Johannes Hämmerle has assembled an extensive collection of artefacts, building parts and models of the traditional houses in the Museum Pusaka Nias in Nias main town Gunung Sitoli. He has been investigating culture and society for 30 years and is most familiar with the situation of the people in Nias and their traditional architecture. For scientific cooperation we could attain the support of Prof. Laretna T. Adishakti, representing ICOMOS Indonesia and the Gaja Mahda University of Yogyakarta.

### 2.2 Aim

The task of this project is the analysis of traditional buildings on the island of Nias. Constructions, types and techniques will be investigated regarding their development, use, function and stability. Detailed descriptions of traditional building techniques will form a valuable collection for further development. The record of solutions found would help to outline their use in future building projects, which should be comparably earthquake-resistant.

Furthermore the scientific publication of the results will be translated into a film-documentation. This allows public access to the scientific results, to communicate the people of Nias a different view on their traditional architecture. Thus the project creates a sensibility about the maintenance of traditional houses or the application of traditional building techniques on new architectural solutions.

In cooperation with Pater Johannes Hämmerle specific projects of preservation and/or design can be granted financial support.

### 2.3 Workflow

In co-operation with Pater Johannes Hämmerle and Laretna T. Adishakti (ICOMOS Indonesia) villages and houses will be selected, which can be used as research examples. Buildings, which have been documented by IVA during a field trip in 2003, will be included into the research. Due to its specific appearance traditional architecture in Nias has been the focus of different research groups in the past. After the recent earthquakes record of damage has been done by national and international organisations. In co-operation with Pater Johannes and Laretna T. Adishakti partners will be defined and contacted. Available records will be examined and integrated into the research.

A first post-earthquake excursion from Austrian side will do a brief building survey, looking for damaged and non-damaged traditional buildings. With this survey and pre-earthquake records a first phase of research can be carried out. Experts in engineering will cooperate to elaborate 3d computer models of the structures being used to test flexibility and deformation under extreme conditions.

A final excursion with architects, building engineers, surveyors and film technicians will focus on the completion of the records. Additional vibration tests and documentation of special features, are defined in the expert review. Simultaneously, local craftsmen will be looked for who are familiar with traditional techniques and invited to participate in the project.

The material of the excursions will be used to outline the value of the traditional building techniques in Nias by means of identification of the crucial factors, which make the structures safe during earthquakes.

## 3. DOCUMENTATION

### 3.1 Conventional approach

Conventionally, architectural documentation includes plans, sections, elevations, sketches and photographs. Video documentation is still seldom used, although moving images allow the understanding of space in a much easier and immediate way.

The documents are usually produced by visiting experts of any kind, not the inhabitants, who would in some respect be much better informed about the "abilities" of their houses.

### 3.2 Integrative approach

In addition to the conventional means of recording in architecture also other methods are used.

Craftsmen in Nias built very accurate wooden models, which explain clearly the structure of the constructions. This is essential, as the roof area is very dark and difficult to measure. Using the principles of the real models, the 1:1 measurements, and virtual 3d modelling tools, the roof construction and spatial relations of the interior can be analysed.

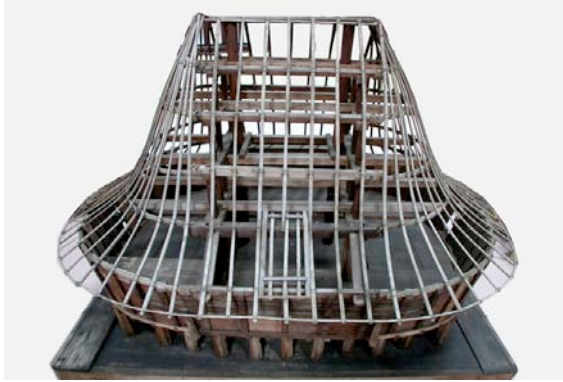


Fig. 11: Wooden model of a house at North Nias



Fig. 12: Roof space in a Central Nias house.

Interviews with the tenants provide information about the history of the buildings and the functions of the rooms. The knowledge of the people can help scientific researchers in many ways. Craftsmen know about the material and the construction in detail and the tenants can give essential information about the building and its significance. Information gained from local people will be essential to avoid misinterpretation and to define changes in architecture, typology and use through the recent earthquakes.



Fig. 13: 3d Model of a South Nias house

Filming can do the combination of different means of recording. Photographs and measures can provide two- and respectively three-dimensional information about the documented object. A video shows movement, adding the fourth dimension of time to the record. Functions and use are clearly visible as well as the daily life of the inhabitants. Furthermore the impact of rain or smoke diffusing through the roof can be shown directly.

With the help of a film documentary the interrelation between people and built and natural environment can be outlined emphatically. In that way this tool of documentation enhances the building survey and supports the work of scientific research.

#### 4. OUTLOOK AND CONCLUSION

The outcome of the described project will be published in a book and in a film documentary. It will be shown to public audiences in Nias to show the people the advantages and lacks of the traditional building techniques.

People will be supported when they decide to renovate their old building or use traditional techniques for the construction of a new house. Financial support will be done by funds, which have been collected after the Tsunami in December 2004 and the Earthquakes Easter 2005. Pater Johannes Hämmerle at mission of the fraternity of the Kapuziner at Gunung Sitoli initiated a kind of adoption for houses. He is raising funds for defined objects and their godparents will be kept informed about the progress.

In winter term 2005 a design program will be carried out at the University of Technology in Vienna at the department of HB2 to apply the findings of the investigation on future architectural projects.

The influence of ecology and society on spatial relations and building will be most important concerning the continuation of these traditional building forms and techniques.

All research material serves as a basis for future research- or applied projects and can be used for the support of the Nias people after these severe catastrophes.

## ACKNOWLEDGEMENTS

We would like to thank all our colleagues, who shared the efforts and outcome of travelling and investigating with us, especially Angela Lehner-Wieternik, Erich Lehner and Günter Zöhrer, and the numerous helpful people we met on our journeys.

## REFERENCES

Hämmerle, J.: Nias - eine eigene Welt  
Academia Verlag, Sankt Augustin 1999

Museum für Völkerkunde, Wien; Leigh-Theisen, H.:  
Der südostasiatische Archipel  
Ausstellungskatalog, Wien 1985

Institut für leichte Flächentragwerke IL (Hg):  
IL14 Adaptable Architecture,  
IL, University of Stuttgart 1975

Oliver, P.: Dwellings  
Phaidon Press Limited, New York 2003

Waterson, R.: The Living House  
Thames and Hudson, 1997

Tjahjono, G. (Ed.): Indonesian Heritage: "Architecture"  
Archipelago Press, Editions Didier Millet, 1998

## IMAGE CREDITS

all Images by the Authors or  
Prof. Erich Lehner, Vienna University of Technology  
Dipl.Ing. Günter Zöhrer

## CONTACT

Petra Gruber is an architect at the Vienna University of Technology, Institute for Architecture and Design, Department for Building Construction HB2, and specializes in architecture and bionics and also works in her own enterprise on architectural implementations.

Petra can be contacted either through her office *hotpen* at [petra@hotpen.com](mailto:petra@hotpen.com) or [gruber@hb2.tuwien.ac.at](mailto:gruber@hb2.tuwien.ac.at)  
Zentagasse 38/1, A-1050 Wien  
Phone: +43 699 19678151

Ulrike Herbig is an engineer of surveying and works on the implementation of an interdisciplinary approach for the recording of cultural heritage. She is chief secretary of the Vienna based Institute for Comparative Research in Architecture.

Ulrike can be contacted through  
[uherbig@teamfactory.at](mailto:uherbig@teamfactory.at) or [uh@iva-icra.org](mailto:uh@iva-icra.org)  
Neubaugasse 36/3/43, A-1070 Wien  
Phone Fax: +43 1 5262274

Petra Gruber and Ulrike Herbig have been working in the executive board of the Institute for Comparative Research in Architecture for three years. Together they create and carry out multi disciplinary research projects in the field of architecture. The Institute can be contacted via [www.iva-icra.org](http://www.iva-icra.org).