Traditional technology in the Kathmandu Valley: the utilization of the soils and sediments

Müller-Böker, U

III. GEOGRAPHY
There can be no doubt as to the fact that the brick houses of the Newars, the farmhouses of the Parbatiyā painted in earthen colours, the traditional craft techniques and, of course, agriculture are all manifestations of culture in the Kathmandu Valley. If traditional technology is understood as an expression of the technological confrontation between man and his natural environment, then it is true that, particularly in pre-industrial societies, this confrontation is characterized by the exploitation of raw materials, of which there are adequate supplies. Due to its geological-morphological situation, the Kathmandu Valley provides its inhabitants with a large number of different soils and sediments, which are put to use in traditional and sometimes ethnospecific ways.

Although “modern” technology and products are now being introduced to the Kathmandu Valley, the traditional utilization of soils and sediments still characterizes the physiognomy of the cultural landscape and the traditional technology. It is part of the cultural identity of the people. Outstanding examples of this are the houses of the Parbatiyā, which can be distinguished from the brick houses of the Newars by their earthen-coloured wash, whereas one associates only one universal kind of culture with the cement-finished façades of modern buildings, that


2. Here Gandhi springs to mind, who promoted the conservation of traditional technology — the spinning wheel as symbol —, not only as part of cultural identity, but also as a political and economic value.

which is common to cities and bazaars all over South and South-East Asia. The list of examples goes on and on: whether it is the plastic bucket which replaces the clay vessel or mineral fertilizer the clay dung; there is always a loss of traditional knowledge of the environment, and, last not least, the abandonment of techniques which are generally cheap and adapted to the environment. The documentation of these traditional techniques seems to me to be all the more important, as ecological and economic problems cannot be solved entirely by technology transfer, but in particular by the further development of the specific know-how of a local population passed down from generation to generation.

I would now like to list a few examples of exploitation and use of various soils and sediments in the Kathmandu Valley (cp. tab. 1). Preliminary to this, however, are a few remarks on geology and morphology of the Kathmandu Valley, so as to explain the origins of the various soils and sediments.

1. *Geological and Morphological Situation*  

During the Pleistocene the Kathmandu Valley was an intramontane lake basin, which, as time went by, was filled with fluvial and lacustrine sediments. Later, the Bāgmati and its tributaries incised the basin filling lake deposits. Of the old tertiary valley system, the watersheds are still left over. They stretch deep down into the valley floor as narrow east-west-oriented basement ridges. The genesis of the lake can be

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5. The change of stratigraphic conditions leads one to believe that it was not a deep lake, but a series of swamps of varying water level (cp. Boesch et al., p. 15, see note 4).

tectonically explained and the sediments have shifted tectonically even after the lake had silted up. The originally horizontally deposited sediments are nowadays inclined at c. 3° to 4° from S to N.

The sediments which fill the basin can be qualitatively categorized according to their origin and conditions of accumulation. The northern mountain range, which consists almost exclusively of granite, produces loose, porous, very micaceous erosion products. The limestone and marble area in the S produces loamy, sandy sediments. The lake sediments are clay deposits ranging in colour from light grey to dark, which pile up the water. They are suitable for the manufacture of bricks and tiles, they are used in pottery and metal casting and also as dyes and for washing. A dark sediment, with a high percentage of organic material, is needed as clay dung and even for certain ritual purposes. To some extent the lake clays are covered by distinctly layered sandy and gravelly horizons, interspersed with clayey deposits sometimes with high carbon content. This material, similar to lignite, is extracted even today for fuel.

Besides the geologically very young sediments deposited in the basin, other residual products from the surrounding mountains, i.e. from the bedrock, are used as earthen colours, weathered pegmatite as chalk and for white dye, latosol as a wash for houses and floors. Latosol is a relict soil, which must have developed in a much warmer climate.

2. The Earthen Colours

Red and yellow soil colours are formed by oxidation. Haematite content produces a particularly intense red colour and goethite a browny-yellow colour. Blue-grey shades are the result of reduction processes with water shut-off. Kaolinite, which in its pure state is perfectly white, is formed under extreme weathering conditions. The black colouring of soil is caused by its C-content.

Red Earth (rāto māṭo / new. siyucā)

Many of the ethnic groups in Nepal use latosol to paint the walls, the doorsteps or floors of their houses. In the Kathmandu Valley, the Parbatiyā apply rāto māṭo dissolved in water on the outside walls, usually combined with other colours. The Newars do not do this. However, both groups use rāto māṭo mixed with cow dung for the smooth, finishing coat on their loam floors, which is renewed several times a year. Floors and doorsteps of a house are also ritually purified with the aid of this red earth-cow dung mixture before certain ceremonies and after ritual defilement. Well-known deposits of rāto māṭo in the area of the Kathmandu Valley are Dhulikhel and Tikābhairaw. Rāto māṭo is also sold in the bazaars (1 tin: c. 1 NR.). The more intense the red colour is, the better the quality.

Yellow earth (pahēlo māṭo / new.- mhāsucā)

Pahēlo māṭo, containing haematite and goethite, is found near Tikābhairaw on the steep bank of the Lele Kholā and is usually only extracted in small quantities for personal use. The Parbatiyā paint their houses with it. When it is of good, fine quality it is used to do the washing.

Sky-colour Earth (ākāsrāg māṭo / new.- niucā)

A silty reduced sediment of light grey to blue-green colour can be found in the small tributaries of the terraced slope towards the Nakhu Kholā (i.e. in a humid area) near Cāpāgāū. Ākāsrāg māṭo is used by the women for washing their hair and occasionally as wall colour, too.


White Earth (seto/kamero māto / new.- tākicā)

A white product of weathered pegmatite is extracted in the Bāgmati gorge. I visited the quarries near Bhaṇḍārikharkā. *Seto māto* is found here in erosion and accumulation rills, which are filled with well-mixed loose material. Shafts of about 5 m in depth and 1,50 m in height are bored vertically into the slope, in which up to five people can work\(^\text{11}\). At the site near Bhaṇḍārikharkā only Tāmāṅg were extracting *seto māto*. At home the material is pulverized and kneaded with water. In a wooden mould with a metal ring the *seto māto* is formed out. The heart-shaped pieces must then be dried for several days, after which they are brought to the towns for sale (1 piece: 0,75-1,25 NR)\(^\text{12}\). *Seto māto* is used as a dye, but also for writing chalk and washing. One family can earn up to 1,000 NR in the peak season — besides agriculture a welcome source of extra cash.

A lacustrine sediment, extracted in the Central Kathmandu Valley, is known as *seto/kamero māto* or new.-tākicā, too. There are quite large tākicā deposits near Thimi on the river terraces. Here, tākicā lies just underneath the uppermost soil horizon, which is first removed. Next, the white clayish tākicā is dug out\(^\text{13}\). The top soil is again spread back over the quarried area. This working of the fields, though, which takes place during the fallow period, is regarded as a method of improving the soil and as such coincides with the farmer’s interests.

The lacustrine tākicā is also mainly used as colour. A very good, long-lasting, white dye can be made from a mixture of boiled wheaten flour and tākicā\(^\text{14}\). Very fine tākicā is taken to do the washing. If a certain chemical substance is added, the result is a kind of soap. Lacustrine tākicā is sold by Newar Jyāpu and Kumāḥ, generally directly to dealers in the towns (2,4 kg: 1 NR).

\(^{11}\) Permission from the village pañcāyat is necessary before one can quarry *seto māto*.

\(^{12}\) A tax of 1 NR for one load (c. 120 pieces) must first be paid to the local village pañcāyat. The dye sellers unanimously declared that they have to pay a further 5 NR as a kind of tax to an office in Pharphiṅ, whose function was unknown to them.

\(^{13}\) Gicā is found underneath the tākicā and is often then extracted by the potters.

\(^{14}\) Lacustrine clays mixed with cow dung and rice husks are also used on plaster both inside and out (cp. Becker-Ritterspach, pp. 121, see note 9).
3. Clays used for pottery

Pure, black clay (kālo māto / new.-hākucā) is the most important material needed for pottery. The potters' workshops of Bhaktapur and Ţhimi are supplied with hākucā mainly from Kāṭunje (south of Bhaktapur). Hākucā is dug off the edges of the terraces in pits or found by removing the soil horizons which cover it.

The Newar potters (Kumāh) mix hākucā with the lighter coloured ġicā for most of their clay vessels. The higher the percentage of hākucā, the better the quality of the finished products. Only "disposable" clay vessels (e.g. drinking bowls) are made of pure ġicā. ġicā, which contains less carbon and is considerably lighter in shade than hākucā, is found in large quantities in the Valley. The potters use other sediments, too, to decorate their clay vessels, which, when fired, turn to shades of yellow and red (containing Fe).

4. Soils Used for Cire Perdue Casting

For the cire perdue casting technique the metal casters (Thākahmi), usually members of the Newar-Śākya caste, need various kinds of sediments for the production of the mould. During the course of several work phases, a clay coating is formed around the wax model. For the first thin layer maśicā is used, a silty, light brown-grey sediment, mixed with powdered cow dung and water. The wax model is dipped into

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16. The deposits near Ţhimi are to a large extent exhausted or not accessible.


18. Also known as mhesicā and masimcā (cp. Michaels, 1985: see note 17).
the mixture. When the first clay coating is dry, a second, thicker layer of \textit{mhāsucā}\(^{19}\) mixed with crushed rice husks and water is applied by hand. This procedure can be repeated several times according to the size of the statue to be made. Untreated \textit{mhāsucā} is sprinkled with yellowish spots, for which reason it is termed as “yellow” soil. In this matter, local terminology is imprecise, as the yellow earthen colour has the same name.

In some cases a further kind of sediment is applied for the final coating of the wax mould: \textit{gathicā}\(^{20}\), an extremely soft sediment, which can also be mixed with crushed rice husks. The workshops are supplied with these sediments by Newar Jyāpu.

5. \textit{Brick and Tile Manufacture}\(^{21}\)

The brick and tile makers (Avāle) usually find their raw material, the lacustrine sediments, in their own fields. The manufacture begins after the rice harvest, when the fields are lying fallow and the dry season has begun. The uppermost soil layer with the rice stalks is removed. The material below can be put to use, if it is soft, pliable and free from impurities. Most of the rice soils in the Kathmandu Valley have these characteristics, but the soil in the South is particularly suitable. There is no precise distinction as to which soil and which horizon is used; it is simply called “\textit{māto}”. Nevertheless, the clay should not be red and a rule of thumb states that fertile khet soil always produces good clay for making bricks and tiles. The extracted clay for bricks and tiles is kneaded with water several times before it is pressed into a wooden mould. The moulds are first treated with sand (\textit{balauṭe māto} / new.\textit{-pācā}),

\(^{19}\) If a figurine is to be cast hollow, the wax mould is filled with \textit{mhāsucā}.

\(^{20}\) Cp. Höfer, p. 196; Michaels, 1985, p. 102, see note 17. The bars of the forges, the smelting furnaces and pots are also made of \textit{gathicā}. In the case of the smelting pots, a further \textit{maśi-} and \textit{mhāsucā} coating is applied. \textit{Gathicā} is used for the manufacture of papier mâché masks, too.

so that the clay can be better removed. The blanks are left to dry in the air for 12 to 14 days\textsuperscript{22}, after which the kiln is set up or repaired.

The traditional rectangular kilns, in which tiles and bricks are fired mainly for personal use, can still be seen in the Kathmandu Valley. Between the outer walls, rows of bricks are piled up, with spaces inbetween for fuel (wood, local “coal”, straw). Several such layers are piled alternately over each other until the kiln is full. The firing is begun at the base of the furnace; later on it is sealed from above. However, commercialized brick manufacture is becoming more and more common in the Valley, due to the building boom. The kilns of the commercial brickworks are considerably larger: They are laid out in an oval and surrounded by a layer of earth. Effective, controlled firing is made possible by a complicated heating and ventilation system and the use of high metal chimneys, which can be dismantled. The actual firing is done in rotation, i.e. flue and heating are moved round in a circle. Each section (c. 25,000 bricks) is fired for about 24 hours. Firing takes place in two phases, the first only with local māṭi koilā, for the second phase Indian hard coal is used.

Example: Brick Manufacture near Harisiddhi

The owner of this commercial brickworks is a Śreṣṭha from Pāṭan. The workers belong to different castes and come from Sākhu, Banepā and the nearby vicinity. About 4 mill. bricks are produced each season. According to the size of the brick, the workers are paid between 50 and 80 NR (1984) for 1,000 blanks. Two people must work on average one day to achieve this target. During the season the Avāle live and work with their families on the working compound. For the actual firing of the bricks, however, skilled workers have been brought in from India, who can master modern firing techniques.

A new area is exploited every year\textsuperscript{23}. The removal of clay means that the level of the fields drops by between 0,5 and 1 m. However, they can be cultivated again the following spring. Only one winter harvest is actually

\textsuperscript{22} Bricks dried only in the open air are also used for building houses (often those of impure castes).

\textsuperscript{23} It is said that on the 1984 compound the same firm was making bricks about 20 years before.
lost. In 1984 the firm rented 100 rop. for 800-1,000 NR/rop. for 6 months. Besides this, compensation had to be paid for the approach road, which roughly made up for the loss of a harvest (2,000 NR/season).

6. Fuel Mining (māṭi koilā)

Māṭi koilā, a ligneous, colloid type of kālimāṭi, is sold in some villages in the Kathmandu Valley during the dry season. It is mainly used to fire the brick kilns. A report in 1955 already pointed out peat fields in Lukundol and in the Bāgmati area. Boesch et al. described the mining of coaly material in the North of the Valley near Phutung. According to some coal dealers, deposits in the Kāli Kholā region east of the Bāgmati up to Buṅgamati and in some areas west of the Bāgmati were being exploited in 1984.

From Cāpāgāũ I visited the mines of the Kāli Kholā, which are said to give best quality māṭi koilā. The māṭi koilā belt lies between kālimāṭi, which contains less organic material, and broad, sandy horizons and is between 30 and 120 cm thick. The layers rise slightly towards the Bāgmati.

Before māṭi koilā may be mined, a license must be obtained from the ministry responsible. The license holder generally rents the mining area for the duration of the works; afterwards he must pay for recultivation. Usually, work begins after Dasaĩ. The mines can only be worked in the dry season and, furthermore, there is only demand for "coal" by the brickworks in winter. First, the main shaft is driven vertically for about 4 m into the slope and then secondary shafts sideways. There are no supporting beams or anything of that sort. Suprisingly

24. A good quality māṭi koilā can even be used for cooking purposes. Powdered "coal" is strewn in the livestock sheds and burnt to keep insects away.


27. The local village paṅcāyat is responsible for the control of all the works. The holder of the license is liable to taxation. If mining damages a house, the license holder has to pay the owner compensation. If two mining fields with different owners should meet, each must keep distance of 7.5 m to the border between them. In the winter of 1984/85 there were five license holders in the Kāli Kholā region.
enough, it is said that no accidents have yet occurred. Before any work is
done in the mine, a small puja is made to request success and safety. After
the extracted mati koilà has dried out a little, it is then carried in baskets
to Càpâgàë.

The workers come from the immediate vicinity and are mostly
Chetri, but there are some Bâhun and Tämâঙ. Day-labourers do the
work involved in opening up the mine. Work in the mine is paid accord-
ing to the amount of raw material won. Together the four men in the Kâli
Khôlà mine received 400 NR for one lorry load (c. 20 to 30 NR/day). The
porters, mostly women and children, are paid according to the load (4,8
kg/1 NR). They can carry one load per day. The mati koilà is sold by the
dealer for 18 NR/man (23 NR/hundred-weight).

Mâti koilà is of low calorific value with a carbon content of only
28.3%28, compared to pure brown coal (carbon content between 70 and
75%). It is therefore doubtful if the mining of mati koilà in the
Kathmandu Valley is economically worthwhile. It seems to be little more
than a relict of the times when there was no road connection to India.

7. Clay Dung

The floors (dol) of the Kathmandu Valley with their soil which has
the ability to pile up water, are particularly suitable for wet rice culti-
vation. However, an overlying stratum of porous sand and gravel often
remains on the terraces. In order to be able to cultivate these areas with
wet rice, too, lacustrine clay has been applied to pile up the water29. Up
to a few years ago kâlimâṭi / new.-hâkucà, rich in nitrogen and carbon,
was still being mined in the Kathmandu Valley and spread on the fields
before the monsoon rains set in. Nowadays, mineral fertilizer is used
almost everywhere in the Valley. Over a short term the farmers achieve
better yields with it, with a high input of capital, but less labour. In the
long run, however, only the regular application of lacustrine clay can
ensure the quite good quality of the rice soils on the terraces.

28. Sample from the above mentioned mine. Raina (see note 25) notes a carbon
content of 15,5% for mati koilà from Lukunôol and 30% from Buûgamati.

biologique du “Kalimati” prélevé dans la vallée de Kathmandou. Rev. d’Ecologie de Biolo-
The inhabitants of the Kathmandu Valley have made use of the favourable ecological conditions of their environment in various ways. Among the natural favours of the Valley are the large number of different soils, sediments and products of weathering, which — as the examples have shown — are put to use for the construction of houses, for handicrafts and agriculture. Besides that, there are still other possibilities of using "māṭo", which are not mentioned here, e.g. the use of earthen colours for paintings and dye-works as well as for ritual purposes.30

Tab. 1: Utilized Soils and Sediments in the Kathmandu Valley

<table>
<thead>
<tr>
<th>Nep.</th>
<th>New.</th>
<th>Location</th>
<th>Origin of Soil Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. rātā māṭo</td>
<td>siyucā</td>
<td>1520 m</td>
<td>Bhāgā Ban, slope under forest small pit</td>
</tr>
<tr>
<td>2. pahēlo māṭo</td>
<td>mhāsucā</td>
<td>1475 m</td>
<td>Tikābhairaw, steep bank of Lele Kholā</td>
</tr>
<tr>
<td>3. ākāsrāg māṭo</td>
<td>niucā</td>
<td>1432 m</td>
<td>WofCāpagāă, c. 20 m beyond the river terrace</td>
</tr>
<tr>
<td>4. seto/kamero māṭo</td>
<td>tākicā</td>
<td>1715 m</td>
<td>S of Bhaṇḍārikharkā, steep slope down to Bāgmanti, grazing land</td>
</tr>
<tr>
<td>5. seto/kamero māṭo</td>
<td>tākicā</td>
<td>1327 m</td>
<td>E of Thimi, river terrace, paddyfield, underneath the Ap, which is removed</td>
</tr>
<tr>
<td>6. kalimāṭi</td>
<td>hākucā</td>
<td>1320 m</td>
<td>Kaṭunje, terraced paddyfield, 2 layers</td>
</tr>
<tr>
<td>7. gīcā</td>
<td>lacustrine sediment, contains kaolinite (C tot.: 0.2%)</td>
<td>1327 m</td>
<td>E of Thimi, river terrace, paddyfield, underneath tākicā A_p/tākicā are removed</td>
</tr>
<tr>
<td>8. maïsicā</td>
<td>lacustrine sediment (C tot.: 0.5%)</td>
<td>c. 2-2.5 m underneath the top layer near reverside</td>
<td>workshop</td>
</tr>
<tr>
<td>9. pahēlo māṭo</td>
<td>mhāsucā</td>
<td>c. 0.5-1 m underneath the top layer, paddyfield</td>
<td>workshop</td>
</tr>
<tr>
<td>10. gathica</td>
<td>lacustrine sediment</td>
<td>thin horizon underneath A_p</td>
<td>workshop</td>
</tr>
<tr>
<td>11. māṭo</td>
<td>cā</td>
<td>1320 m</td>
<td>N of Harsiddhi, paddyfield</td>
</tr>
<tr>
<td>12. māṭi koilā</td>
<td>lignitic, organic sediment (C tot.: 28.3%)</td>
<td>1340 m</td>
<td>Kāli Kholā Valley, layer: 0.3 to 1.2 m thick, between kālimāṭi and sandy horizons</td>
</tr>
</tbody>
</table>

(Traditional Technology in the Kathmandu Valley)
<table>
<thead>
<tr>
<th>Colour acc. to Munsell</th>
<th>Distribution of Particle Size in %</th>
<th>Used for</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sand</td>
<td>Silt</td>
</tr>
<tr>
<td>dry</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. 5yr 5/8 yellowish red</td>
<td>27.5</td>
<td>42.8</td>
</tr>
<tr>
<td>2. 10yr 6/8 brownish yellow</td>
<td>48.1</td>
<td>38.7</td>
</tr>
<tr>
<td>3. 5y 6/2 light olive gray</td>
<td>5.6</td>
<td>85.9</td>
</tr>
<tr>
<td>4. 5gy 7/1 light greenish gray</td>
<td>24.9</td>
<td>52.9</td>
</tr>
<tr>
<td>5. 2,5y 8/0 white</td>
<td>3.8</td>
<td>51.6</td>
</tr>
<tr>
<td>6. 5y 4/1 dark gray</td>
<td>2.8</td>
<td>48.3</td>
</tr>
<tr>
<td>7. 10yr 7/2 light gray</td>
<td>2.1</td>
<td>52.8</td>
</tr>
<tr>
<td>8. 2,5y 6/2 light brownish gray</td>
<td>3.8</td>
<td>81.0</td>
</tr>
<tr>
<td>9. 10yr 7/3 very pale brown</td>
<td>18.8</td>
<td>62.1</td>
</tr>
<tr>
<td>10. 10yr 5/2 grayish brown</td>
<td>5.0</td>
<td>43.7</td>
</tr>
<tr>
<td>11. 2,5y 7/2 light gray</td>
<td>7.8</td>
<td>65.2</td>
</tr>
<tr>
<td>12. 2,5y 7/2 light gray</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(Munsell: Soil Colour Chart, 1971)

(* Michaels, 1985, p. 88, see note 17)