

Non-agricultural soil uses by communities in uMgungundlovu District and their safety for use

**Authors:**

Rebecca Zengeni¹ 
Noxolo Hlatshwayo¹ 

Affiliations:

¹Department of Soil Science,
School of Agriculture, Earth
and Environmental Science,
University of KwaZulu-Natal,
Pietermaritzburg,
South Africa

Research Project Registration:**Project Number:**

IKS14072881194

Corresponding author:

Rebecca Zengeni,
zengeni@ukzn.ac.za

Dates:

Received: 02 Mar. 2023

Accepted: 03 Nov. 2023

Published: 29 Dec. 2023

How to cite this article:

Zengeni, R. & Hlatshwayo, N.,
2023, 'Non-agricultural soil
uses by communities in
uMgungundlovu District
and their safety for use',
Inkanyiso 15(1), a70. <https://doi.org/10.4102/ink.v15i1.70>

Copyright:

© 2023. The Authors.
Licensee: AOSIS. This work
is licensed under the
Creative Commons
Attribution License.

Read online:

Scan this QR
code with your
smart phone or
mobile device
to read online.

South African communities, especially in rural areas, still use indigenous practices such as applying soil paste as sunscreen, building huts with soil and stones and geophagia among others. This study aimed at identifying non-agricultural uses of soil in uMgungundlovu district of KwaZulu-Natal, South Africa, while focusing on the three areas Elandskop, KwaNxamalala and Willowfontein. Information was gathered using key informant interviews and household questionnaires. Results showed that the most common soil uses were for cosmetics and as geophagia, followed by construction, with medicinal use being the least common. Cosmetic use involved using soil as sunscreen or skin cleaner. While geophagic soil was mostly consumed for enjoyment, to satisfy cravings and least of all as a nutrient supplement. Medicinal soil was mostly used to treat wounds and skin ailments such as rashes and acne. Users believed that their pre-treatment methods such as boiling, burning or baking before use were effective in reducing microbial loads and other contaminants in the soil.

Contribution: This study describes and elucidates on the non-agricultural uses of soil by communities and their safety to users.

Keywords: Indigenous soil use; geophagia; cosmetics; safety for use; non-agricultural.

Introduction

The safety of soil for use in cosmetics, medicinal purposes, geophagia and pottery have not been well explored. The arrival of modern cosmetics did not change the reliance on soil for dermatological beautification (Matike, Ekosse & Ngole 2010) as traditional use of soil for cosmetic purposes is still a common practice among many African communities (Matike et al. 2010). African women, especially those who reside in rural areas, also use local soils for photo-protection (Matike, Ekosse & Ngole 2011). These mix red soil (*ibomvu* in isiZulu) or white soil (*umcako* in isiZulu) with water to produce a paste that is applied onto the face (Dlova et al. 2013). Red soil paste is also applied onto traditional incisions or scars to aid in fast healing (Magwa 2006). Here, soil used for cosmetics is mainly distinguished by colour, with white and red soil being preferred.

Geophagia is the intentional ingestion of earth material (Mathee et al. 2014), which dates back historically in African communities (Phakoago 2017). A variety of reasons for practising geophagia include religious, nutritional and medicinal benefits, enhancement of personal appearance, pregnancy-related cravings and enjoyment of the taste, texture or smell of the soil (Mathee et al. 2014). The prevalence of geophagia differs widely but is still practised in many parts of the world. Geophagic soils across the African continent are unique in origin. While vendors in South Africa get geophagic soils from the wilds of mountains, valleys and riversides, those from Kenya and Tanzania source them from termite mounds (Phakoago 2017). The physical properties of soil such as their texture, structure, colour, smell and taste play an important role during selection (Ekosse, DE Jager & Ngole 2010). Our study sought to understand whether users were aware of the dangers posed by soil use and whether they had strategies to curb them.

Pottery and the construction of houses are among other practices that utilise local soil. In South Africa, there are many different types of traditional housing structures. In the Eastern Cape, a traditional hut can be built using wooden poles, with gaps between poles filled using a strong type of grass then plastered with soil. Other traditional huts can be built using stones that are then plastered with soil (Makaka & Meyer 2006). In the KwaZulu-Natal (KZN)

province, there are still homesteads built with mud blocks and painted with an earthy coloured finish (*umcako* or *ibomvu*) (Mhlaba 2009). Research indicates that pottery vessels as ancient times were used for cooking, water storage and sorghum beer brewing (Fowler 2011). Potters in Umsinga district, KZN use clay (*ubumba* in isiZulu) to make vessels. These clays are sampled from dry stream beds, with soil types that include reddish-brown Rensburg and Katspruit calcareous soils (Fowler 2011). With all these vast uses, it is important to know how safe soil is to users. Mpuchane et al. (2010) investigated cosmetic soils from Swaziland, Botswana and South Africa and found only 14 of the 102 soil samples to have faecal coliform contamination. Bisi-Johnson, Obi and Ekosse (2010), also reported geophagia to have a range of health complications such as constipation, stomach cramps, parasitic infestation and dental damage. The aim of the study was thus to assess non-agricultural soil uses practised by people in selected communities of uMgungundlovu district and how they ensure safety for use. This was performed through a survey in three communities using questionnaires and key informant interviews. Specific objectives included:

Objectives

1. To assess the local people's knowledge about non-agricultural uses of soil.
2. To identify processing and handling techniques used to ensure safety of soil for use.

Research methods and design

Site description

The study was conducted in three areas, namely Elandskop (S29.7274° E30.1350°), KwaNxamalala (S29.7078 E30.3045°) and Willowfontein (S29.7185 E30.3151°) that fall under the uMgungundlovu district of uMsunduzi local municipality in KwaZulu-Natal province (Appendix 1).

Research design and sampling procedure

Information was gathered through interviews with key informants and household questionnaires. The participants were chosen according to their availability and willingness to participate in the survey. Both genders were represented in the survey as much as possible depending on willingness of respondents to participate. Interviews were conducted in the local Zulu language, which was familiar to the participants. The duration of the interviews was 15–20 min.

Key informant interviews

The interviews were conducted on five members of each community. These included councillors, agricultural officials, as well as vendors who sell their soils in Pietermaritzburg. The interviews were performed to identify the primary non-agricultural soil uses.

Baseline survey

A questionnaire with structured questions was administered to community members after the KIIs (with non-structured questions) were used to identify the most common soil uses and that served to provide detail in understanding the guiding principles behind these uses. These questionnaires targeted 50 people per area (which was a representative number per area) making a total of 150.

Statistical analysis

Data were analysed using SAS Institute Incl 9.4 statistical package, (2013). Demographic information such as gender, age and educational level was analysed using the PROC FREQ procedure of SAS 9.4 Institute. The responses were coded according to the frequency of use. When coding gender, for example, females were denoted number one while males were coded number two (SAS 9.4 Inst.2013). The PROC GLM procedure SAS 9.4 using least mean squares was used to analyse the responses. These were ranked from 1 for frequently used, with a higher number representing decreasing frequency of use. The results of ranking were described using the least mean square, with a lower mean square describing the most used variable.

Ethical considerations

Biomedical Research Ethics Committee of UKZN gave ethical clearance and approved this study. The researchers also obtained gatekeeper permission from community leaders in each study area before embarking on the study. BE582/17.

Results

Demographic information of respondents from the study areas

There were more females than men that participated in the survey in all areas (as it is mostly women who are soil users), with Willowfontein having 82% female respondents, followed by Elandskop with 76%, and KwaNxamalala with 66% (Table 1). The ages of participants varied, but mostly ranged between 18 and 30 years in all areas, with Willowfontein having 44%, Elandskop 38% and KwaNxamalala 36% of participants in this age group. The educational level was dominated by participants who had secondary education, with 76% in Elandskop, while Willowfontein and KwaNxamalala had 62% each. Very few people had no formal education, that is 8 % in KwaNxamalala, 4% in Elandskop and 2% in Willowfontein.

The non-agricultural soil uses in the study areas

Table 2 presents mean scores of common soil uses in Elandskop, KwaNxamalala and Willowfontein, with lower values representing the most commonly used and higher values the least used. Soil is mostly used for cosmetics in all areas, followed by geophagia in KwaNxamalala and Willowfontein, while in Elandskop the second most

TABLE 1: Demographic information of respondents from study sites.

Demography	Category	Elandskop	KwaNxamalala	Willowfontein
Gender (%)	Female	76	66	82
	Male	24	34	18
Age (%)	18–30	38	36	44
	31–40	16	18	24
	41–50	18	20	8
	51–60	12	20	6
	61–70	12	6	12
	> 70	4	-	6
Educational level (%)	Primary	18	18	22
	Secondary	76	62	62
	Tertiary	2	12	14
	No formal education	4	8	2

TABLE 2: Common non-agricultural soil uses in the study areas.

Common non-agricultural soil uses	Least square means		
	Elandskop	KwaNxamalala	Willowfontein
Cosmetics	1.53 [†]	1.67 [†]	1.67 [†]
Geophagia	2.73 [‡]	1.98 [†]	2.04 [†]
Medicinal	3.52 [‡]	3.53 [‡]	3.06 [†]
Construction	1.77 [†]	2.36 [‡]	2.29 [‡]
Pottery	ND	ND	ND

ND, not determined (not chosen as a response).

Values in the table represent the least mean square (Lsmeans) of common non-agricultural soil uses with lower values being the most used. Values with the same superscript letters are not significantly different at $p < 0.05$.

common use was construction. There were no significant differences in soil use for cosmetics in all areas ($p > 0.05$), while geophagic use was more popular in KwaNxamalala and Willowfontein. More respondents from Willowfontein used soil for medicinal purposes compared with the other two areas, while there were more respondents using it for construction in Elandskop. None of the respondents used soil for pottery in any area of the study.

The uses of soil applied onto the skin

Table 3 presents information on soil applied onto the skin, with soil being mostly used as sunscreen in all areas. The use of soil as sunscreen or skin cleanser did not significantly differ in any of the three areas. Traditional trainees (undergoing training to be traditional healers) apply a soil paste during initiation, which could be red or white for identification purposes (Nyawose 2013). This practice is the second most common skin soil use in KwaNxamalala and Willowfontein. Umemulo is a ritual performed when a Zulu girl is transitioning to womanhood and involves application of red and white soil to the body as skin cleanser (Magwa 2006). This soil use proved to be the least popular in the areas of the study.

Reasons for practising geophagia in the study areas

The most common reasons for practising geophagia included cravings and enjoyment (Table 4). The practice of geophagia as a nutrient (iron) supplement was more common at Willowfontein but not the other two areas. No significant differences between areas were observed in the use of soil for enjoyment.

TABLE 3: Different uses of soil applied onto the skin.

Soil use	Least square means		
	Elandskop	KwaNxamalala	Willowfontein
Sunscreen	1.06 [†]	1.02 [†]	1.02 [†]
Skin cleanser	1.94 [†]	2.60 [†]	2.50 [†]
Applied by traditional trainees (ukuthwasa)	2.41 [‡]	2.0 [†]	2.25 [‡]
Applied for ritual purposes (umemulo)	3.05 [†]	2.88 [†]	2.96 [†]

Values in the table represent the least square means for soil skin application, with lower values being the most used. Values with the same superscript letters are not significantly different $p > 0.05$.

TABLE 4: The main reasons for practising geophagia in the study areas.

Reasons for geophagia	Least significant means		
	Elandskop	KwaNxamalala	Willowfontein
Cravings	1.16 [†]	1.55 [‡]	1.32 [†]
Nutrient supplement	3 [‡]	3 [‡]	1 [†]
Enjoyment	1.52 [†]	1.33 [†]	1.29 [†]

Values in the table represent the least square means of reasons to practise geophagia, with lower values being the most common. Values with the same superscript letters are not significantly different $p > 0.05$.

Use of soil for medicinal purposes

The use of soil for medicinal purposes was practised most when treating traditional incisions locally called ukugcaba (more so at KwaNxamalala and Willowfontein), followed by treating skin ailments such as rashes and acne (Table 5). This was characterised by application of a soil paste onto the wound or skin ailment. The use of soil to treat indigestion was performed more at KwaNxamalala than Willowfontein, while there was no evidence of this at Elandskop. Community members in Willowfontein also use soil to treat diarrhoea.

The sources of soil used for various purposes

Data on sources of soil could not be shown because of limitations on tables and graphic numbers by the journal. However, results showed that soil used for cosmetics was mostly collected from the mountain (38.87%), by the roadside (24.49%) or bought from vendors (22.45%) in Elandskop. While in KwaNxamalala cosmetic soil was mostly obtained from the mountain (45.83%), vendors (33.33%) and by the riverside (16.67%). In Willowfontein the dominant sources of cosmetic soil were the mountains (73.4%), with a few samples bought from vendors or collected by the roadside (10.20% in each case). Geophagic soil samples on the other hand in Elandskop were mostly obtained by the roadside (76.62%), with a few bought from vendors (15.38%). In KwaNxamalala, however, geophagic soil was mostly from the mountain (59.57%) or near roadsides (36.17%). In Willowfontein most geophagia practitioners get their soil by the roadside (75%), with a few from the mountain (20.83%). The soil used for medicinal purposes was mostly bought from vendors in Elandskop (35.71%) or got from the mountain (32.14 %), which was more or less the same pattern as in KwaNxamalala. In Willowfontein, most medicinal soil is sourced from the mountain (68%). However, construction soil is mostly sampled around the yard (homestead) in all three areas: Elandskop (90.70%), KwaNxamalala (79.41%) and Willowfontein (88.89%).

TABLE 5: The use of soil for medicinal purposes in the study areas.

Medicinal use	LS means		
	Elandskop	KwaNxamalala	Willowfontein
Skin problems	1.78 [†]	1.71 [†]	1.29 [†]
Indigestion	ND	1	3
Diarrhoea	ND	ND	2
Traditional incisions(ukugcaba)	1.26 [‡]	1.05 [†]	1.06 [†]

ND, not determined (not chosen as a response); LS, Least significant.

Values in the table represent the least square means of uses of soil for medicinal purposes with lower values being the most used. Values with the same superscript letters are not significantly different $p > 0.05$.

There were, it is again to be observed, no users of pottery soil in the three communities studied.

Sampling techniques used to collect geophagic soil by users

Figure 1 shows the different techniques used to collect soil for geophagia. The most frequently used sampling method was digging with a knife especially in KwaNxamalala and Elandskop. This was followed by sampling using a spade particularly in Willowfontein, which was not significantly different from selective hand-picking. Sampling using a hand-hoe proved unpopular, more so in Willowfontein.

Methods of storing geophagic soils

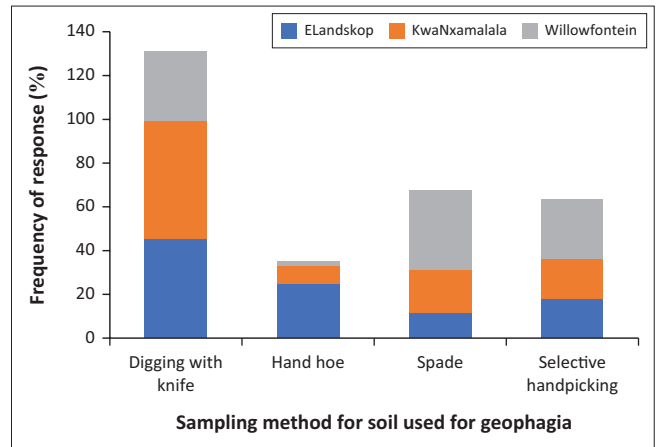
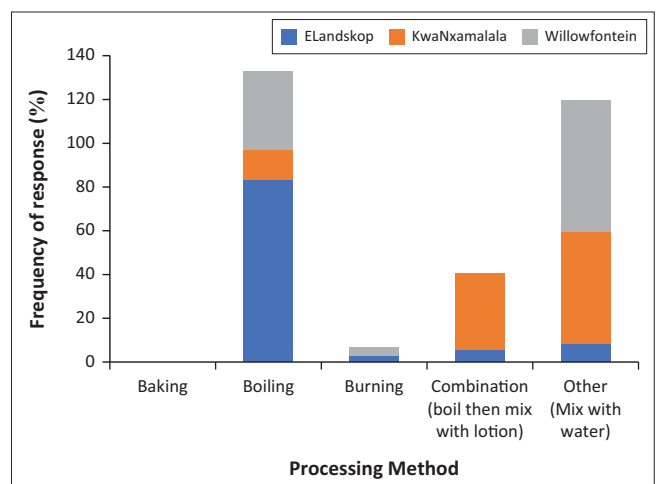
The storage options for soil used for geophagia could also not be shown because of figure number limitations by the journal. Nevertheless, the study showed that soil samples are mostly stored in plastic bags, followed by plastic containers (e.g. lunchboxes), with sacks being the least popular storage option in all areas. The use of plastic bags was more common in KwaNxamalala, as compared with Elandskop and Willowfontein, while the use of containers was more common in Elandskop and Willowfontein than KwaNxamalala.

Methods used to process soil applied onto the skin

Figure 2 shows the sample preparation options for soil applied onto the skin (cosmetics purposes). Boiling seemed to be the most popular soil treatment technique, especially at Elandskop. Here soil is boiled in water, cooled then used as a paste that is applied onto the skin. Soil burning (although not so popular) involves moistening soil with water then moulding into a ball structure before hardening by fire. Soil baking is almost similar to burning, the only difference being that a pan is used instead when heating the soil. Another popular option (denoted as 'combined') is when users added commercial lotion to a boiled soil paste before application. This is performed in an attempt to prevent skin dryness induced by the soil paste. In some instances (denoted as 'other'), users mixed soil with boiled water soon after sampling to make a paste, which is then applied on the skin.

The side effect of using soil for different goals

Table 6 shows the respondents' perceptions about side effects of using soil for different purposes. In the case of cosmetic soil, side effects included pinkish blemishes on the

**FIGURE 1:** Sampling methods used for geophagic soil.**FIGURE 2:** Precautionary soil treatment methods before applying on skin.**TABLE 6:** The side effects of using soil for different purposes in the study areas.

Soil use	Condition	Elandskop (%)	KwaNxamalala (%)	Willowfontein (%)
Cosmetic	Blemishes	20.83	63.64	14.29
	Skin irritation	50	22.73	71.43
	Other (dry skin)	29.17	13.64	14.29
Medicine	Nausea	0	0	0
	Constipation	60	0	0
	Diarrhoea	20	0	0
	Other (skin irritation if used for traditional incision (ingcabo))	20	0	0
Geophagia	Constipation	75.68	39.02	60.61
	Stomach ache	5.41	17.07	0
	Other (appendix infection, gall stones)	18.92	43.90	39.39
Construction	Dry hands	97.37	96.97	85.71
	Ring worm	2.63	3.03	14.29

Values shown as percentage of respondents in each area.

cheekbones, skin irritation or creation of dry skin (especially if the soil is not well prepared or mixed with lotion). Skin blemishes were more common at KwaNxamalala, while skin irritation was more prevalent at Willowfontein and dry skin at Elandskop. The side effects for soil used for medicinal purposes included constipation and diarrhoea, but these were only reported at Elandskop. The other side effect of skin irritation also occurred when soil was used on traditional

incisions. Soils used for geophagia gave rise to problems of constipation mostly, while other complications include stomach aches, development of gall stones or infections of the appendix. In construction, the dominant side effect was the drying of hands (from gritty soil) as a result of soil mixing during construction. The other minor side effect of construction was the development of skin ring worms.

Discussion

More females than males participated in the survey. This was because men thought women were more knowledgeable about non-agricultural soil uses because these practices were usually undertaken by women. All interviewees were at least 18 years of age, because people below 18 were considered rather unknowledgeable as far as soil uses are concerned. The older generation also had low numbers, with users being mostly between 18 and 50 years. This could be because most soil users are women, who consume it (because of cravings developed during pregnancy) or use it for cosmetic purposes to enhance their beauty. S'khosana (2017) in a study in uMzinyathi and uMgungundlovu showed cravings to be the main reason for practising geophagy by women. The reasons for practising geophagia that we observed in the survey was mostly cravings or simple enjoyment. Songca et al. (2010) in a study to understand the demographic characteristics associated with geophagia also found that consumers had strong cravings for soil. The literacy level of participants was mostly secondary education, while there were very few people with no formal education. The study showed common soil uses to be cosmetics and geophagy, with construction and medicinal uses being not that popular, while pottery did not appear to be practised at all in the studied areas. Cosmetic soil was mostly used as sunscreen or a skin cleanser, but in some cases, soil was applied by traditional trainees for ritual purposes such as umemulo. Dlova et al. (2013) suggested that women use soil as a sunscreen because they cannot afford commercial products. Elandskop and KwaNxamalala are semi-rural areas where women are often involved in chores such as gardening that exposes them to UV light, so they apply a soil paste to protect them from the sun. This shows that although users might not have the scientific knowledge, they have an understanding that soil offers some protection or can serve as a cleanser to their skin. There is evidence to show that soil is a common ingredient in toners and cleansers that are used commercially in beauty spars. Smit (2011) in a study of textural properties of soil used as cleanser by traditional trainees showed that 50% – 70% of the soil samples had particle diameters of 2 µm – 20 µm, which were similar to those of clay mixtures used for cleansing in commercial Thermal Centres. Common colours of soil applied on skin by users were white and red. Mpuchane (2010) reported these colours together with yellow, grey and brown to be commonly used in several modern cosmetics products such as face powders, lip gloss, eye shadow and blushers; as they influence the sun screening and toning abilities of such products.

Medicinal soil is mainly practised by traditional healers to heal incisions. These are scars made by a sharp object in the face to show which clan one belongs to. Here red soil is applied to heal the incisions or wounds in general (Magwa 2006). Matike et al. (2011) also highlighted the vast uses of soil by traditional initiates to include it serving as a deep cleanser, toner or for identification purposes during initiation. As discussed, users also apply soil to treat skin problems such as acne and rashes, while the use of soil to treat indigestion is less common. Bisi-Johnson et al. (2013) reported that soils containing minerals such as aluminosilicate, kaolinite or montmorillonite commonly had a glue-like property that promoted attachment of microorganisms and nutrients. This might explain their effectiveness in treating ailments, but more work needs to be carried out on this.

The survey showed that respondents in all areas sourced soil from different places, with cosmetic soil mainly sampled from mountains or bought already processed from vendors. A few users also collected it from riverbanks and roadsides. Matike et al. (2010) found that users collected soil samples from riverbanks and roadsides for cosmetic use. Dlova et al. (2013) in a study in Durban again found the most common source of soil for cosmetic use to be near riverbanks. Soil used as geophagia was mainly collected by the roadside in excavations opened during road construction as well as from mountains, while a few users in the study areas bought it directly from vendors. In a study in Limpopo, Mpanama respondents also collected geophagic soil from mountains (Phakoago 2017).

In the case of sampling techniques, most geophagic soils were sampled by digging using a knife, spade, hand-hoe or selective handpicking in all areas. A study by Msibi (2014) also found that most consumers collected soil by digging using a knife. Soil processing was mainly performed for cosmetic soil, while for geophagia, respondents consumed the soil directly as is without processing it. After collection, the soil used for cosmetics was treated by boiling with water in an effort to lower pathogenic microbial populations, as users believe the heat from the boiled water is effective in killing pathogens. This was also done to make the soil smoother when applying.

According to the respondents, there are side effects associated with the different soil uses. Cosmetic soil use, for example, may cause skin blemishes, irritation and dryness. These side effects are worsened by over-application of the soil paste or applying it without it having been mixed with lotion. According to the respondents, geophagic soils may cause constipation, appendicitis and gallstones. Msibi (2014) as well as Phakoago (2017) also observed that geophagic soil caused severe constipation by binding with mucus inside the intestines.

These findings indicate that the study managed to provide an overview of soil uses, with users convinced that their storage and handling techniques (boiling, burning and baking) made the soil safe for use. However, the limitation of

the research was that it was mostly performed in peri-urban areas because these were easily accessible from the university. More uses such as pottery could have been explored in deeper rural areas. In short, the study found that in addition to enjoyment of geophagic soil, users felt selected soils were an effective sunscreen and skin cleanser and were safe for use as long as heat treatment (and sometimes the addition of lotion to prevent dryness) was performed for cosmetic soil. Some users even suggested that soil use was effective at treating wounds and other skin ailments such as acne and rashes. Respondents highlighted that care should be taken, however, not to over-consume geophagic soil (as it could cause problems of constipation and development of gallstones among others), while over-applying cosmetic soil could cause skin dryness.

Conclusion

The study revealed that soil use for non-agricultural purposes is still common practice, with women users applying it as a sunscreen or conditioner or consuming it for enjoyment, while males use it in construction. Traditionally, soil is applied during ceremonies and rituals, while medicinal use to treat traditional incisions or wounds was not very common. With all our study areas being peri-urban, pottery was not practised at all. Pottery use might be a practise that is common in deeper rural areas, so more research on this could be directed there. In an attempt to ensure safety for use of cosmetic soil, users process the soil through heat treatment, for example boiling, burning or baking before use. Users believe such pre-treatment is effective in reducing microbial contaminants in soil. Users are aware of the health challenges (constipation, skin irritations etc.) associated with consuming soil but strongly believe that their pre-treatment methods decontaminate soil so that it is safe for use. More comparative analysis on microbial (particularly of pathogens) and heavy metal loads before and after heat treatment of the soils to ensure effectiveness of safety measures employed by users have been probed in a separate study. The validity of effectiveness of soil to treat ailments such as skin rashes, acne, wounds, indigestion and diarrhoea needs further investigation.

Acknowledgements

The authors would like to thank the research assistants at UKZN for helping in data collection during the survey.

Competing interests

The authors have declared that no competing interest exists.

Authors' contributions

R.Z. conceptualised the research idea, was supervisor of the MSc research project and contributed to writing and editing of the manuscript. N.H. was an MSc student on the project who collected and analysed the data, as well as wrote the manuscript.

Funding information

This study was funded through an NRF research grant with project number IKS14072881194.

Data availability

The authors confirm that the data supporting the findings of this study are available within the article and its supplementary materials.

Disclaimer

The views expressed in the submitted article are our own and not an official position of the institution or funder.

References

- Bisi-Johnson, M.A., Obi, C. & Ekosse, G., 2010, 'Microbiological and health related perspectives of geophagia: An overview', *African Journal of Biotechnology* 9(19), 5784–5791.
- Bisi-Johnson, M.A., Oyelade, H.A., Adediran, K.A. & Akinola, S.A., 2013, 'Microbial evaluation of geophagic and cosmetic clays from Southern and Western Nigeria: Potential natural nanomaterials', *International Journal of Environmental, Chemical, Ecological, Geological and Geophysical Engineering* 7(12), 832–835.
- Dlova, N.C., Nevondo, F.T., Mwangi, E.M., Summers, B., Tsoka-Gwegweni, J., Martinicigh, B.S. et al., 2013, 'Chemical analysis and in vitro UV-protection characteristics of clays traditionally used for sun protection in South Africa', *Photodermatology, Photoimmunology Photomedicine* 29(3), 164–169. <https://doi.org/10.1111/phpp.12042>
- Ekosse, G.E., DE Jager, L. & Ngole, V., 2010, 'Traditional mining and mineralogy of geophagic clays from Limpopo and Free State provinces, South Africa', *African Journal of Biotechnology* 9(47), 8058–8067. <https://doi.org/10.5897/AJB10.296>
- Fowler, K.D., 2011, 'The Zulu ceramic tradition in Msinga, South Africa', *Southern African Humanities* 23, 173–202.
- Magwa, L.P., 2006, 'A critical evaluation of the use of skin as a form of identity in Zulu culture', Master's dissertation, Durban Institute of Technology.
- Makaka, G. & Meyer, E., 2006, 'Temperature stability of traditional and low-cost modern housing in the Eastern Cape, South Africa', *Journal of Building Physics* 30(1), 71–86. <https://doi.org/10.1177/1744259106065674>
- Mathee, A., Naicker, N., Kootbodient, T., Mahuma, T., Nkomo, P., Naik, I. et al., 2014, 'A cross-sectional analytical study of geophagia practices and blood metal concentrations in pregnant women in Johannesburg, South Africa', *South African Medical Journal* 104(8), 568–573. <https://doi.org/10.7196/SAMJ.7466>
- Matike, D., Ekosse, G. & Ngole, V., 2010, 'Indigenous knowledge applied to the use of clays for cosmetic purposes in Africa: An overview', *Indilinga African Journal of Indigenous Knowledge Systems* 9(1), 138–150.
- Matike, D., Ekosse, G. & Ngole, V., 2011, 'Physico-chemical properties of clayey soils used traditionally for cosmetics in Eastern Cape, South Africa', *International Journal of Physical Sciences* 6(33), 7557–7566. <https://doi.org/10.5897/IJPS11.1249>
- Mhlaba, D., 2009, 'The indigenous architecture of KwaZulu-Natal in the late 20th century', Master's dissertation, University of KwaZulu-Natal.
- Mpuchane, S.F., Ekosse, G.E., Gashe, B.A., Morobe, I. & Coetzee, S.H., 2010, 'Microbiological characterisation of southern African medicinal and cosmetic clays', *International Journal of Environmental Health Research* 20(1), 27–41. <https://doi.org/10.1080/09603120903254025>
- Msibi, A.T., 2014, 'The prevalence and practice of geophagia in Mkhanyakude District of KwaZulu-Natal, South Africa', Master's dissertation, University of KwaZulu-Natal.
- Nyawose, T.Z., 2013, '“Living in two worlds”: Optimizing our indigenous knowledge systems to address the modern pandemic, HIV and AIDS', PhD dissertation, Durban University of Technology.
- Phakoago, M.V., 2017, 'Geophagic practice and characterisation of plant remains in geophagic soils in Sekhukhune Area, Limpopo Province, South Africa', Master's dissertation, University of Venda.
- S'khosana, L.H., 2017, 'The prevalence and nutritional status of woman between the ages of 18 to 45 years, practicing geophagia in the Umzinyathi and uMgungundlovu Districts, KwaZulu-Natal', Master's dissertation, University of KwaZulu-Natal.
- Smit, N.J., 2011, *A qualitative study of selected micro-organisms in geophagic soil from Qwa-Qwa*, Central University of Technology, Free State, Bloemfontein.
- Songca, S., Ngole, V., Ekosse, G. & DE Jager, L., 2010, 'Demographic characteristics associated with consumption of geophagic clays among ethnic groups in the Free State and Limpopo provinces', *Indilinga African Journal of Indigenous Knowledge Systems* 9, 110–123.

Appendix 1: Map of study area

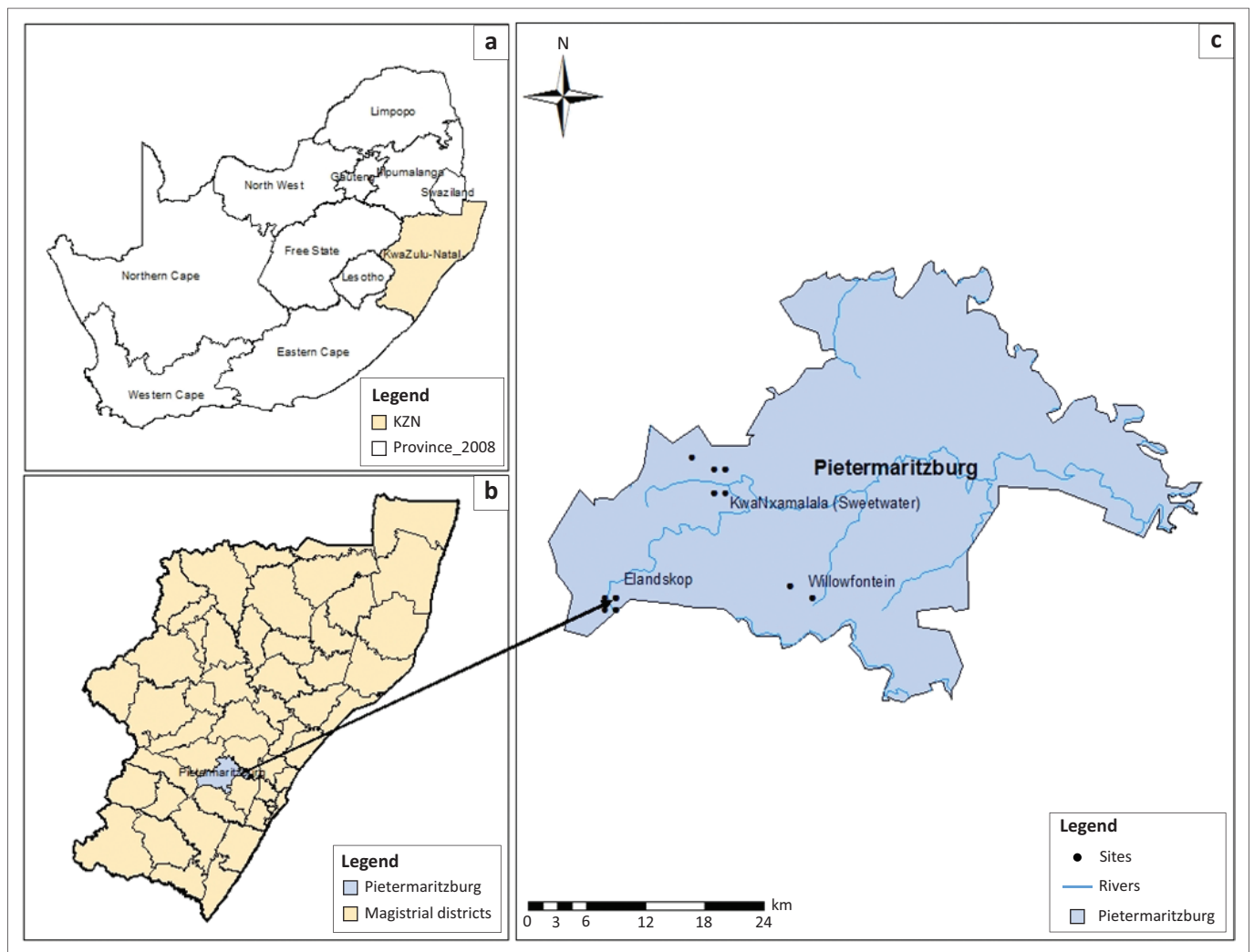


FIGURE 1-A1: The study was conducted in three areas, namely Elandskop ($S29.7274^{\circ}$ $E30.1350^{\circ}$), KwaNxamalala ($S29.7078$ $E30.3045^{\circ}$) and Willowfontein ($S29.7185$ $E30.3151^{\circ}$) that fall under the uMgungundlovu district of uMsunduzi local municipality in KwaZulu-Natal province.