International Journal of Research and Review
Volume 11; Issue: 3; March 2024
Website: www.ijrrjournal.com
Research Paper *E-ISSN: 2349-9788; P-ISSN: 2454-2237*

Contribution to the Management and Valorization of Fecal Sludge in the Urban Commune of Kissidougou, Mamou, Republic of Guinea

Yakouba TRAORE[1], Ansoumane SAKOUVOGUI[2], Mamby KEITA[3], Mafory BANGOURA[4]

[1]Department of Physics, Higher Institute of Educational Sciences of Guinea, Guinea.
[2]Energy Department, Mamou Higher Institute of Technology, Guinea.
[3]Department of Physics, Faculty of Sciences, Gamal Abdel Nasser University of Conakry, Guinea.
[4]Department of Chemistry, Faculty of Sciences, Gamal Abdel Nasser University of Conakry, Guinea.

Corresponding Author : Yakouba TRAORE

DOI: https://doi.org/10.52403/ijrr.20240319

ABSTRACT

Background and Aim : This research is a continuation of our work on the management and recovery of domestic waste. Its general objective is to take stock of the fecal sludge in the urban commune of Kissidougou, with a view to proposing appropriate treatment techniques. So, to achieve this objective, we carried out a field survey in the twenty-four neighborhoods of the urban commune, where we met ten households per neighborhood, or two hundred and forty households.
Method : The specific production methods, characteristics of sanitation works, demand for mechanical emptying, and turnover of the emptying operator were used
Results : The results obtained show that the housing typology of Kissidougou is characterized by a dominance of low standing estimated at 61%, followed by 37% of medium standing compared to only 2% of traditional type. Wastewater and excreta sanitation works are mainly traditional with 61%, followed by septic tanks with 14%, 13% improved latrines, 10% without specific purpose and only 1% VIP. The frequency of emptying is estimated at 40% for between 2 to 5 years, 29% (more than 2 years), 19% of the population surveyed, once the latrines are full, they give up; 7% have not changed their oil for 10 years; Likewise, 51% of the population do manual emptying; while 43% have an imprecise method of emptying their works; 4% empty their works mechanically and only 1% (other and not yet emptied). For a population of nearly 110000 inhabitants, the estimated annual specific production of faecal sludge is 64240 m^3/year, or a specific production depending on households of 3014 m^3/year. The quantity of sludge mechanically drained per year is 0.4m3/year; that manually is 6.24 m^3/year. Thus, the characteristic of the sanitation works gives 314.12 m3/year and that of the operation of the mechanical emptying operator is 730 m^3/year.
Conclusion : The results show that 30% of the population do not know how much they paid to empty their latrines ; while 18% say they paid 300000 GNF, 13% paid 350000 GNF ; 10% invested 450000 GNF for emptying their latrines, 8% of the population paid 400000 GNF and others 500000 GNF ; 6% of respondents said nothing about the emptying situation ; 5% pay 650000 GNF and 4% do their emptying at 600000 GNF.

Keywords: Faecal sludge, sanitation works, Management and recovery

INTRODUCTION

Faecal sludge is residue of all kinds from individual sanitation systems such as septic

tanks, bucket latrines, pit latrines, on the one hand and public toilets on the other [1]. They may or may not undergo partial treatment during the storage period [2]. The dry matter and organic matter contents as well as the concentrations of ammonium and helminth eggs measured in fecal sludge are at least ten times higher than in wastewater [3].

The composition of the sludge depends on the nature of the pollutant load of the raw effluents and the treatment techniques. We thus distinguish: primary sludge, physicochemical sludge, biological sludge and thick sludge [4].

The sludge production facilities are: traditional dry pit latrine, ventilated pit latrine or improved latrine, flush toilet and septic tank. Sludge emptying in developing countries is currently done using three technological options: mechanical emptying, semi-mechanical emptying and manual emptying [5].

The choice of a fecal sludge treatment technology depends mainly on the characteristics of the sludge generated as well as the treatment objectives (agricultural reuse, landfill of biosolids or discharge of treated liquids into receiving watercourses) [6].

In developing countries, the sanitation of wastewater and excreta constitutes both a mission and a concern. Access to suitable sanitation systems constitutes a major axis for poverty reduction since sanitation is more than ever linked to health, social issues, the environment and therefore to development. Lack of sanitation and hygiene (poor management of excreta) is a source of transmission of various diseases, such as diarrheal diseases. They are the cause of the death of more than 1.5 million people each year, nearly 90% of whom are children under 5 years old [7]. In West African cities such as Guinea, only 5% of homes are connected to a sewer network [8].

When the contents of a latrine are dumped into the compound, the street, or into fields, the risks to the environment and public health are much higher than those linked to discharges of gray wastewater. The problem then concerns the intermediate (evacuation/transport) and downstream (treatment/recovery) links in the on-site sanitation chain in this city because some households already have facilities (30%) [9]. It therefore becomes imperative that the municipality has a BV unloading and processing site.

The general objective of this research is to contribute to the optimal management of fecal sludge in the urban commune of Kissidougou in Guinea.

MATERIALS AND METHODS

Study framework

Kissidougou is a prefecture of Guinea located approximately 600 km from the capital Conakry, in the Faranah Administrative Region. It is between 9°11' North latitude and 10° 06' West longitude then extends over an area of 8872 km2 with an average altitude of 525 m. Kissidougou has a dry harmattan savannah climate characterized by the alternation of two main seasons, a dry season and a rainy season. Kissidougou prefecture is an area with significant rainfall almost all year round with an average of 1083.9 mm of water per year. The dry season lasts from November to March. The average annual temperature in Kissidougou is 26.2°C. From a hydrographic point of view, the main watercourse that crosses the prefecture is the Niandan River.

The population of the urban commune of Kissidougou recorded in 2014 is estimated at 110000 inhabitants, with an average annual growth of 5.10% over the 12-year period. It is therefore the sixth most populous city in the country, after Conakry, N'Zerekore, Guéckédou, Kankan, Kindia and Boké [10]. In Kissidougou, we meet several different ethnic groups and dialects including Kouranko, Kissi, Lélé, Malinke, Pular and others. The city includes twenty-four (24) districts which are: Hamdallaye, M'Ballia, Hérémakono, Timbo, Kénèma, Missira, Gbanban, Douninkono, Madina I, Madina II, Sogbé I, Sogbé II, Sogbé III, Korodou I, Korodou II, Yassafè Koura, Yassafè Koro,

Ernesto, TP, Limanya, Marah, Kérédou, Daresalam and Farako.

Kissidougou prefecture is subdivided into thirteen (13) sub-prefectures, namely: Kissidougou-Centre, Albadaria, Banama, Bardou, Beindou, Fermessadou-Pombo, Firawa, Gbangbadou, Kondiadou, Manfran, Sangardo, Yendé-Millimou and Yombiro. The main socio-economic activities of Kissidougou prefecture are trade, agriculture, livestock breeding, fishing and gathering. The study area is illustrated in Figure 1.

Map of Kissidougou

Figure 1 : Study area

METHODOLOGY

The survey methodology to consist of doing; two survey sheets, one of which was aimed at authorities at all levels and the other at different households. In the twenty-four (24) neighborhoods of the urban municipality, we met ten (10) households per neighborhood, or two hundred and forty (240) households. The survey on the socio-urban planning aspects of the urban commune of Kissidougou concerns the typology of housing, gender, age, marital status, religion, ethnicity, main activity, level of education and the special status of the head of household.

The quantification of sludge is an essential parameter; several methods for quantifying the volumes of fecal sludge produced have been developed. We can cite the specific production methods, the demand for mechanical emptying, the characteristics of the sanitation work and the turnover of the emptying operator. The specific production method is based on the quantity of sludge produced per inhabitant, per day, per type of structure and the number of inhabitants. The total quantity of sludge produced in a locality is given by formula 1 [11].

$$Q = 365 \times \sum P_i \times \frac{q_i}{1000} \qquad (1)$$

Q [m^3/year]: total quantity of sludge produced per year; P_i: Number of people using type i latrine; q_i [L/day/inhabitant]: Specific production of sludge for type i latrine, i: Typology of sanitation works [12].

The mechanical drain demand method is based on the mechanical drain demand. It depends on the number of rotations carried out per truck per day, the volume emptied per rotation, the average frequency of emptying of the installations and the proportion of the population using truck service. In the case of several trucks, the parameter should be the average of the useful volumes of the trucks. The total amount of mechanically drained sludge is determined by formula 2.

$$Q_{méc} = \sum N \times \frac{P_{mec}}{F_{mec}} \times v_i \times n_i \qquad (2)$$

N: Total number of structures existing in the locality; Q_{mec} [m^3/year]: quantity of sludge drained mechanically P_{mec} [%]: proportion of structures drained mechanically; $Fmec$ [an]:

frequency of emptying of mechanically drained structures; v_i [m^3/rotation]: useful volume of the truck (in cases where there are several trucks, take the average of the useful volumes) n_i [rotations/work]: Number of rotations necessary to empty a type i sanitation work . It is calculated by relating the useful volume of the truck to the average volume of the work in question i: typology of sanitation works [13].

The method of characteristics of the sanitation works is based on the results of the characterization of autonomous sanitation works. To take into account the fact that the truck does not suck up all the contents of the pit, there is a correction coefficient. This correction does not concern structures emptied manually because they are generally completely emptied of their contents (formula 3, 4 and 5) [14].

$$Q_{mec} = \sum N \times \frac{P_{mec}}{F_{méc}} \times v_i \quad (3)$$

$$Q_{man} = \sum N \times \frac{P_{man}}{F_{man}} \times v_i \quad (4)$$

$$Q = Q_{mec} + Q_{man} \quad (5)$$

Q_{mec} [m^3/year]: quantity of sludge produced in mechanically drained structures; Q_{man} [m^3/year]: quantity of sludge produced in structures drained manually pméc [%]: Proportion of structures drained mechanically; P_{man} [%]: proportion of structures emptied manually; F_{mec} [an]: average frequency of mechanical emptying; F_{man} [an]: average frequency of manual emptying N [works]: total number of works existing in the locality ; V_i [m^3]: average volume of sanitation works V_i: correction coefficient to take into account the volume of bottom sludge not sucked up by the truck.

The emptying operator's turnover method is based on the operating account of the emptying operators from which the number of rotations carried out per year is deducted. This method makes it possible to estimate the quantity of sludge drained mechanically (formula 6).

$$Q_{mec} = N_{rot} + v \quad (6)$$

N_{rot}: number of rotations per year, obtained by relating the turnover to the emptying rate v [m^3/rotation]: volume actually drained per rotation [15].

RESULTS AND DISCUSSIONS

The results obtained during this study are illustrated by the graphs in Figures 2 to 8 and Table 1 (see below).

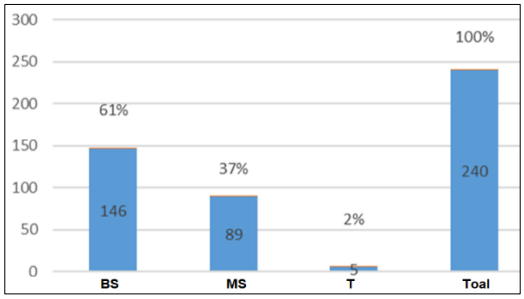

Figure 2. Housing typology

From this graph, it appears that the housing typology of the urban municipality is characterized by a dominance of low standing (BS) estimated at 61%, followed by 37% of medium standing (MS) compared to only 2% of traditional type (T). Graph 3 gives the wastewater and excreta sanitation works encountered.

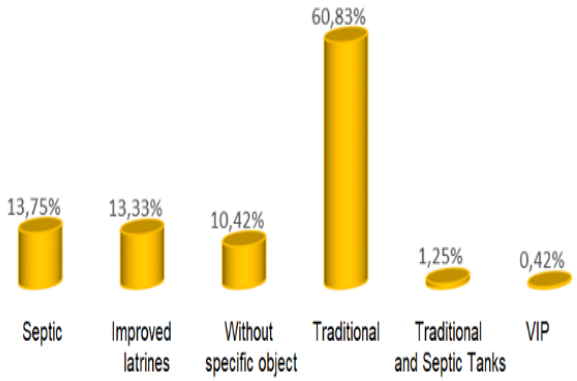

Figure 3. Wastewater and excreta sanitation works encountered

This graph illustrates that wastewater and excreta sanitation works are mainly traditional with 61%, followed by septic tanks with 14%, 13% improved latrines, 10% without specific purpose and only 1% VIP. Graph 4 gives the frequency of emptying carried out by households.

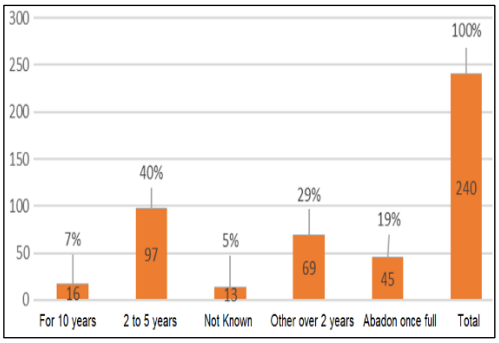

Figure 4. Emptying frequency

This graph tells us that the frequency of emptying is estimated at 40% for between 2 to 5 years, 29% (more than 2 years), 19% of the population surveyed, once the latrines are full, they give up. 7% have not changed the oil for 10 years and 5% do not know. Graph 5 shows how households empty latrines.

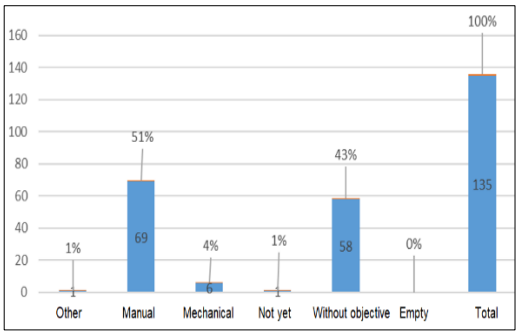

Figure 5. Way of draining

The result of our field survey shows that 51% of the population do manual emptying, while 43% have a method which is not precise for emptying their works, 4% empty their works mechanically and only 1% (other and not yet emptied). Graph 6 represents the world of fecal sludge use.

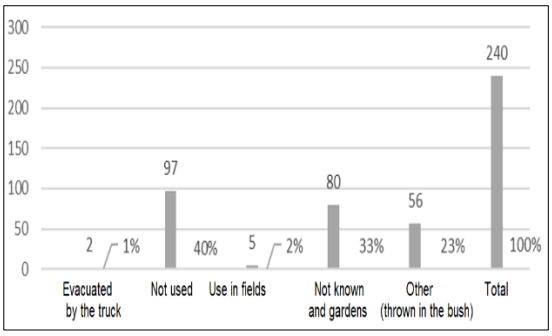

Figure 6. Use of fecal sludge

From this graph, the use of BV by the population is not yet considered. This is why the survey proves that 40% do not use them, 33% do not know their usefulness, only 2% use them in the fields and gardens and 1% are evacuated by trucks, these results are consistent with those of other authors [16]. Figure 7 shows the types of latrines used by households.

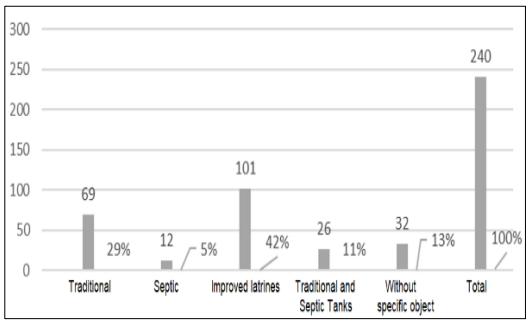

Figure 7. Types of latrines

It appears from this graph that the surveyed population uses 42% type of improved latrines, while 29% traditional type, 13% non-specific type, 11% traditional and septic tanks and 5% have septic tanks, these values are slightly lower than those found in Mamou in 2023 [3]. Table 1 represents the annual production of BV by the urban commune of Kissidougou.

Table 2. Annual production of BV in the urban municipality

N°	Production	Symbol	Quantity	Unit
1	Specific production according to population	Q	64240	m^3/an
2	Specific production according to households	Q	3014	m^3/an
3	Mechanical drain	Q_{mec}	0.4	m^3/an
4	Manual emptying	Q_{man}	6.24	m^3/an
5	Characteristics of sanitation works	Q	314.12	m^3/an
6	Operating account of the mechanical emptying operator	Q_{mec}	730	m^3/an

For a population of nearly 110,000 inhabitants, the estimated annual specific production of faecal sludge is 64240 m^3/year, or a specific production depending on households of 3014 m^3/year. The quantity of sludge mechanically drained per year is

0.4m^3/year; that manually is 6.24 m^3/year. Thus, the characteristic of the sanitation works gives 314.12 m^3/year and that of the operation of the mechanical emptying operator is 730 m^3/year. The graph in Figure 8 gives the costs of emptying by households [17].

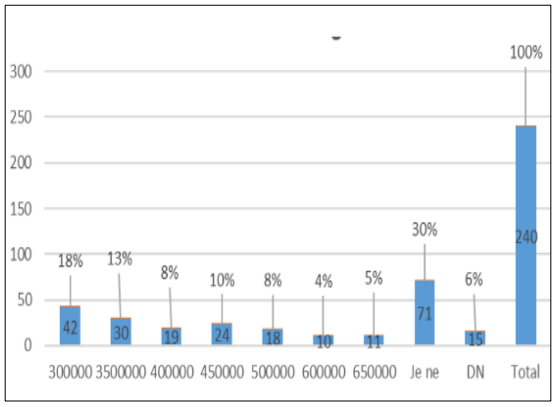

Figure 8. Emptying price.

This graph illustrates that 30% of the population do not know how much they paid to empty their latrines, while 18% say they paid 300000 GNF, 13% paid 350000 GNF, 10% invested 450000 GNF for emptying their latrines. their latrines, 8% of the population paid 400000 GNF and others 500000 GNF, 6% of respondents said nothing about the emptying situation, 5% pay 650000 GNF and 4% do their emptying at 600000 GNF.

CONCLUSION

In developing countries in general and in the Republic of Guinea in particular, the problem of sanitation (wastewater and faecal sludge) constitutes a major challenge for specialists and local authorities.

This research made it possible to take stock of the management of fecal sludge in the urban commune of Kissidougou. The specific production methods, characteristics of sanitation works, demand for mechanical emptying, the method of characteristics and the method of turnover of the emptying operator used, allowed us to obtain convincing results for adequate and sustainable management of fecal sludge in the commune of Kissidougou. The results of this present work will allow us to propose to the municipality a type of optimal sludge treatment work.

Declaration by Authors

Acknowledgement: None
Source of Funding: None
Conflict of Interest: The authors declare no conflict of interest.

REFERENCES

1. Strande, L., Schoebitz, L., Bischoff, F., Ddibab, D., Okello, F., Englund, M., Ward, B.J., Niwagaba, C.B. Methods to reliably estimate faecal sludge quantities and qualities for the design of treatment technologies and management solutions. J. Environ. Manag. 223 (2018) 898–907. doi: 10.1016/j.jenvman.2018.06.100
2. Englund, M., Carbajal, J. P., Ferré, A., Bassan, M., Vu, A. T. H., Nguyen, V. A., and Strande, L. Modelling Quantities and Qualities (Q&Q) of Faecal Sludge in Hanoi, Vietnam and Kampala, Uganda for Improved Management Solutions. Journal of Environmental Management 261: 110202 (2020). https://doi.org/10.1016/j.jenvman.2020.110202.
3. Barry T. A., Sakouvogui A., Sakho A. M., Keita M., Contribution to the Management of Fecal Sludge in the Urban Commune of Mamou (Republic of Guinea). Journal of Environmental Science and Engineering A6, Volume 12, Number 1, ISSN 2162-5271 (2023) 223 - 228,
4. GUILAVOGUI W. D., SAKOUVOGUI A., BAYO I., KEITA M., DIABY I., Essay the Recovery of Solid Household Waste fromThe City of Kindia by Composting, (Republic of Guinea). International Journal of Research and Review, Vol. 10; Issue: 4, E-ISSN: 2349-9788, (2023) 133 à 138. https://doi.org/10.52403/ijrr.20230417
5. Ahmed, I., Ofori-Amanfo, D., Awuah, E., and Cobbold, F. A Comprehensive Study on the Physicochemical Characteristics of Faecal Sludge in Greater Accra Region and Analysis of Its Potential Use as Feedstock for Green Energy. Journal of Renewable Energy, Article ID 8696058 (2019). https://doi.org/10.1155/2019/8696058.
6. Daloba, S., Mangué, S., Ansoumane, S., and Mamby, K. Determination of the

Microbiological Characteristics of the Fecal Sludge of the City of Conakry. World Journal of Advance Healthcare Research 3 (4) (2019)109-12.
7. Soumah, D., Bangoura, A. O., Sakouvogui, A., and Diallo, A. D. Comparative Study of the Physicochemical Characteristics of the Sludge from the City of Conakry. World Journal of Pharmaceutical and Life Science 6 (8) (2020) 373-37.
8. BAH N G. D, KENGNE T. J., YOGBACK G. E., MOTCHEMIEN R., Epanensako dejeannot, njogi bella anne rosine eve. faecal sludge eco-treatment design system proposal in a tropical climate : casestudy of Bafoussam Western- Cameroon. International Journal of Innovation Scientific Research and Review Vol. 05, Issue, 07, (2023) 4815 – 4820. http://www.journalijisr.com
9. Christian W., Ebenezer S. K., Guy V. D. W. Wilfried Arsène Letah Nzouebet, Pierre Nbendah , Yvan Anderson Tchangoue Ngandjui, Louis Zapfack, Ives Magloire Kengne Noumsi. Quantification and characterisation of faecal sludge from on-site sanitation systems prior the design of a treatment plant in Bangangte, West Region of Cameroon. Environmental Challenges 5 (2021) 100236, 8p.
10. Sakouvogui A., Beavogui V., Guilavogui W. D., Sidibe A. and Keita M. Study of the Management and Recovery of Biodegradable Waste in the City of Kankan, Guinea, Journal of Environmental Science and Engineering B 12, Volume 12, Number1, ISSN 2162-5271, ISSN : 2162-5271, (2023) 17 - 24,. 10.17265/2162-5263/2023.01.002
11. Douanla, M.P., Soh, K.E., Djumyom, W.G.V., Letah, N.W.A., Nounja, Z.M., Liegui, G.S., Wanda, C., Fotso, N.I.M.Kengne, Quantification and characterization of faecal sludge from a tropical urban area: the case study of Douala-Cameroon. Int. J. Biol. Chem. Sci. 13, (2019) 105–113. doi: 10.4314/ijbcs.v13i5.8S .
12. Englund M., Carbajal J.P., Ferré A., Bassan M., Hoai Vu A.T., Nguyen V. A., Strande L. Modelling Quantities and Qualities (Q&Q) of Faecal Sludge in Hanoi, Vietnam and Kampala, Uganda for Improved Management Solutions. J. Environ. Manag (2020) 261, 110202.
13. Molle, P., Fournel, J., Meyer, D., Extensive Systems for the Managementand Treatment of Urban Water during Rainy Weather. Technical guide, 43 (2013) hal-02599141.
14. Junglen, K.; Rhodes-Dicker, L.; Ward, B.J.; Gitau, E.; Mwalugongo, W.; Stradley, L.; Thomas, E. Characterization and Prediction of Fecal Sludge Parameters and Settling Behavior in Informal Settlements in Nairobi, Kenya. Sustainability (2020) 12, 9040.
15. Strande L., Schoebitz L., Bischoff F., Ddiba D., Okello F., Englund M., Ward B.J., Niwagaba C.B. Methods to Reliably Estimate Faecal Sludge Quantities and Qualities for the Design of Treatment Technologies and Management Solutions. J. Environ. Manag 223 (2018) 898 - 907.
16. Wanda C., Kengne E.S., Wafo G.V.D., Nzouebet W.A.L., Nbendah P., Ngandjui Y.A.T., Zapfack, L., Noumsi I.M.K., Quantification and Characterisation of Faecal Sludge from On-Site Sanitation Systems Prior the Design of a Treatment Plant in Bangangte, West Region of Cameroon. Environ. Chall. 5 (2021) 100236.
17. Tazen F., Diarra, A. Kabore R.F.W, Ibrahim B, Bologo M., Traoré K., Karambiri H. Trends in Flood Events and Their Relationship to Extreme Rainfall in an Urban Area of Sahelian West Africa: The Case Study of Ouagadougou, Burkina Faso. J. Flood Risk Manag (2019) 120 - 125.

How to cite this article: Yakouba TRAORE, Ansoumane SAKOUVOGUI, Mamby KEITA, Mafory BANGOURA. Contribution to the management and valorization of fecal sludge in the urban commune of Kissidougou, Mamou, Republic of Guinea. *International Journal of Research and Review*. 2024; 11(3): 144-150. DOI: *https://doi.org/10.52403/ijrr.20240319*

******