ResearchGate

See discussions, stats, and author profiles for this publication at: https://www.researchgate.net/publication/51992661

Sand Dunes Fixation in Baiji District, Iraq

Article *in* Journal of China University of Geosciences · March 2002

CITATIONS
13

READS
1,024

1 author:

Ayad M. Fadhil Al-Quraishi
Tishk International University

185 PUBLICATIONS **1,778** CITATIONS

SEE PROFILE

All content following this page was uploaded by Ayad M. Fadhil Al-Quraishi on 19 August 2019.

The user has requested enhancement of the downloaded file.

Journal of China University of Geosciences, Vol. 13, No. 1, p. 67—72, March 2002 ISSN 1002—0705
Printed in China

Sand Dunes Fixation in Baiji District, Iraq

Ayad Mohammed Fadhil
Faculty of Earth Resources, China University of Geosciences, Wuhan 430074

ABSTRACT: This study was carried out at Sand Dunes Stabilization Researches Station in Baiji district (230 km north of Baghdad, Iraq) to evaluate the effects of local soil conditioners manufactured from oil derivatives and plant residuals on sand dunes fixation as the first step for sand dunes stabilization. The results indicate that the fuel oil has the first place in improving wind erosion parameters in the study area, such as increasing mean weight diameter, dry aggregates percentage, the needed time for complete disaggregation by dry sieving, and decreasing the disaggregation rates. Bitumen emulsion occupies the second place, while the plant residuals occupies the third place and has slight effects on the studied parameters. Effects of conditioners on natural vegetation cover are negative in oil derivatives treatments, while positive in plants residuals treatments.

KEY WORDS: sand dunes fixation, soil conditioners, wind erosion, Iraq.

INTRODUCTION

Most of Iraqian lands are affected by wind erosion and formation and movement of sand dunes, particularly in the middle and south of Iraq. The total area covered by sand dunes is approximately 2 millions hectares. And there are another millions of hectares threatened by sand dunes (Dougrameji and Kaul, 1972).

Sandy soils and sand dunes are located around Baiji in the north, in an area northeast of Hilla-Diwaniyah and in a sand belt, more or less parallel to the Euphrates situated in an NW-SE direction south of a line Najaf Zubair with a width ranging from 5 to 25 km. The general movement of dunes is in a southeast direction as a result of prevailing northwest winds as shown in Fig. 1 (Dougrameji, 1979).

In Iraq, there are two types of sand dunes. The first type is pseudo sand dunes that contain high percentages of silt and clay, such as the sand dunes in the middle and south of Iraq. The second type is the true sand dunes containing high percentage of sand, such as the sand dunes located in Baiji district (230 km north of Baghdad, Iraq).

Due to the serious problems caused by sand dunes movements and their bad effects on cities, urban and rural areas, factories, communication lines,

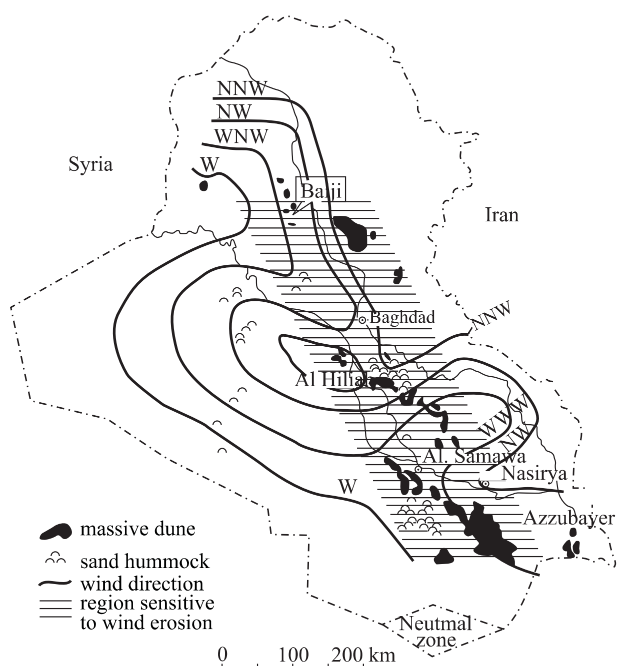

Figure 1. Sandy soils and sand dunes in Iraq (Dougrameji (1979)).

agricultural lands, irrigation and drainage canals and air pollution, it becomes very important and very necessary to combat sand dunes movement. There are many methods for this aim, one of which is to use soil conditioners as a mulch technique (spreading any products or materials capable of evenly covering the soil) for sand dunes fixation as the first step for sand

Manuscript received September 7, 2001.
Manuscript accepted January 3, 2002.

dunes stabilization (FAO, 1993).

Armbrust (1977) proposed to use mulches (natural or manufactured materials) for improving soil structure and soil erosion control. Also De Benito (1974) suggested using oil derivatives sprayed with rates 4—8 tons/hectare for sand dunes fixation. Ben Salem (1985) proposed to use oil derivatives such as asphaltic oil, waxy oil and crude oil to prevent sand dunes movement.

Not only oil derivatives were used for sand dunes fixation, but also the plant residuals. Stevens (1974) paid attention to the importance of the organic matter and other plant residuals in sand dunes fixation and stabilization. Mitchell (1974) stated that the plant residuals were incorporated by plow with sands in addition to bitumen emulsion for sand dunes fixation in Australia. Christensen (1986) indicated that plant residuals were incorporated with sandy loam soil that increased soil aggregation and waster content as well.

MATERIALS AND METHODS

The aim of this study conducts on sand dunes at Baiji station for the researches of sand dunes fixation and stabilization in Baiji district (230 km north of Baghdad, Iraq) is to evaluate the efficiency of some local soil conditioners manufactured from oil derivatives and plant residuals on sand dunes fixation. Completely randomized block design was used in field experiment including three blocks vertically located in prevailing wind direction at the study area. Each block contained fifteen plots for fifteen treatments; each plot area was 50 m^2 (5 m × 10 m). The local conditioners, whose details are shown in Table 1, treated sand dunes in the experiment field. Each block contained fourteen treatments (plots) as well as control treatment (one plot). Control treatment was not treated with any type of conditioners.

Triplicate random soil samples were obtained periodically from surface layer (0 — 5 cm) to estimate the content of soil moisture. Another random soil samples were collected carefully to estimate the other studied parameters. Chemical analysis was made by the methods mentioned by US Salinity Laboratory Staff (1954), while organic matter analysis done by Wakley-Black method (Jackson, 1958). Physical analysis was carried out to estimate the following parameters: mean weight diameter as wet sieving method, which was suggested by Youker and McGuinness (1957); disaggregation rate and the needed time for complete disaggregation of dry aggregates by the methods mentioned by El-Hady (1984); The percentage of dry aggregates (>0.84 mm) named by Chepil (1950) as non-erodible particles; bulk density and real density were estimated as cold method and pycnometer method respectively mentioned by Black et al. (1965); percentage of soil particles as Kilmer and Alexander method illustrated in US Salinity Lboratory Staff (1954); soil moisture was calculated by the weight method.

The obtained data were analyzed statistically according to completely randomized blocks design, and

Table 1 Treatments, their symbols, soil conditioners, and their levels used in this study

treatments	conditioners spraying levels						comments
	first	symbol	second	symbol	third	symbol	
fuel oil	0.5 liter/m^2	Fo1	1 liter/m^2	Fo2	2 liter/m^2	Fo3	oil product
bitumen emulsion	1 %	Bt1	2.5 %	Bt2	5 %	Bt3	oil derivative
Bakaz	6 ton/hectare	Bk1	12 ton/hectare	Bk2	—	—	cane residuals
Kewaleh	6 ton/hectare	Kw1	12 ton/hectare	Kw2	—	—	crushed empty corncob
Sus	6 ton/hectare	So1	12 ton/hectare	So2	—	—	Licorice's roots residuals
supermoss	6 ton/hectare	Sm1	12 ton/hectare	Sm2	—	—	organic fertilizer
control		c					no conditioners added

Table 2 Chemical characteristics of surface layer of studied sand dunes in Baiji district, Iraq

electrical conductivity	pH	$w(CaCO_3)$/%	organic matter/%	soluble ions/(mol · l^{-1})							
				$c(Ca^+)$	$c(Mg^+)$	$c(Na+)$	$c(K^+)$	$c(SO_4^-)$	$c(Cl^-)$	$c(CO_3^-)$	$c(HCO_3^-)$
0.32	7.64	18.38	% 0.09	2.00	0.8	0.25	0.36	3.10	3.60	—	1.20

Table 3 Physical characteristics of surface layer of studied sand dunes in Baiji district, Iraq

soil particles/%			soil texture	density/(kg · m^{-3})		total porosity
sand	silt	clay		bulk	true	
93	2.7	4.3	S	1 601	2 682	40.3

differences among the treatment values were tested by Duncan test. Tables 1, 2 and 3 illustrate the treatments, their symbols and the used levels and the chemical and physical characteristics of studied sand dunes.

RESULTS AND CONCLUSIONS

Effects of Conditioners on Mean Weight Diameter

The results of this study as shown in Fig. 2 indicate that fuel oil treatments surpass the other treatments in increasing mean weight diameter and their effects are high and statistically significant. It reached 3.4, 4.93 and 5.56 mm for the first, second and third levels of fuel oil treatments, while it is 0.186 mm for control treatment.

Bitumen emulsion exerts positive effects on mean weight diameter of sand dunes, increasing the studied parameter to a statistically significant height. It reached 1.44, 2.37 and 2.74 mm for the first, second and third levels. In other words, it increases mean weight diameter 8, 12, 14 times in comparison with control treatment.

Effects of plant residuals are slight in comparison with oil derivatives in increasing mean weigh diameter.

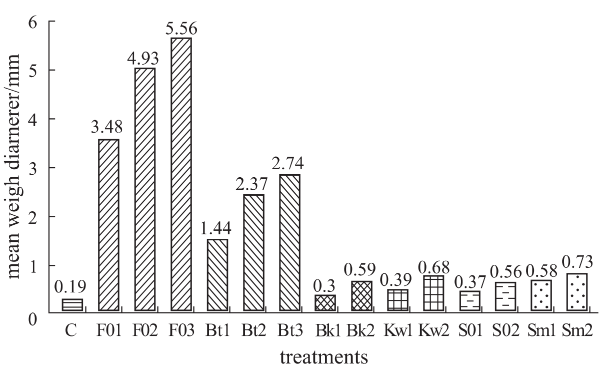

Figure 2. Effects of conditioners on mean weight diameter.

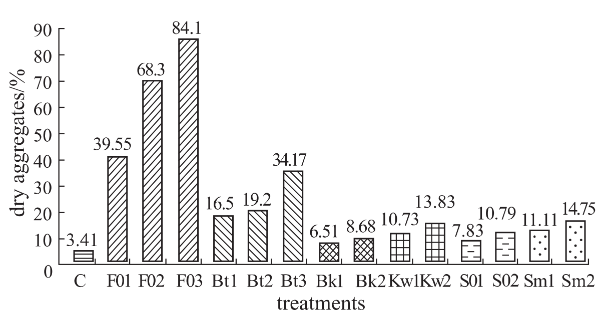

Figure 3. Effects of soil conditioners on percentage of dry aggregates.

Effect of Soil Conditioners on Percentage of Dry Aggregates

The results indicate that the percentages of dry aggregates (>0.84 mm) which are named as non erodible fractions by Chepil (1950) are increased after mulching the sand dunes by fuel oil and bitumen emulsion.

Figure 3 shows that fuel oil treatments at all levels surpass all other treatments in increasing the percentage of dry aggregates. They are 39.6 %, 68.3 % and 84.1 % for the first, second and third levels respectively. Other means increase 2, 20 and 25 times respectively in comparison with control treatment.

The presence of fuel oil increases dry aggregates. Fuel oil has sticky nature that helps to connect and join particles of the soil together. Also the results indicate that bitumen emulsion increased the percentage of dry aggregates in sand dunes where its effects are highly significant (>0.01 p). It increases dry aggregates 5, 6 and 10 times in comparison with control treatment. It reaches 16.5 %, 19.2 % and 34.2 % for the first, second and third levels respectively.

The increase in percentages of dry aggregates due to the sticky nature of bitumen emulsion plays an important role in connecting soil particles and forming soil aggregates.

Plant residuals have less effect than fuel oil and bitumen emulsion. As shown in Fig. 2, the percentage of dry aggregates in the second levels (high concentrations) of the treatments is 8.7 %, 13.8 %, 10.8 % and 14.7 % in Bk2, Kw2, So2 and Sm2 respectively, while it is 3.4 % in control treatment.

From the statistical analysis, we find that there is high positive correlation ($r = 0.979^{**}$) between the percentage of dry aggregates which its diameter is more than 0.84 mm in the surface layer of sand dunes and mean weight diameter.

Effects of Soil Conditioners on Disaggregation Rates and Needed Time for Complete Disaggregation of Dry Aggregates

Fuel oil treatments surpass all other treatments in reducing disaggregation rates. Its effects are statistically significantly high at all its spray levels as shown in Fig. 4. The differences in disaggregation values among control treatment that is -21.3×10^{-3} and fuel oil treatments are so high, which reach -6.7×10^{-3}, -2.6×10^{-3} and -1×10^{-3} for the first, second and third levels of fuel oil treatments,

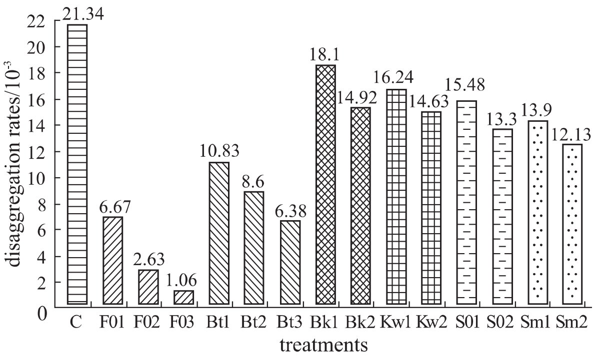

Figure 4. Effects of soil conditioners on disaggregation rates.

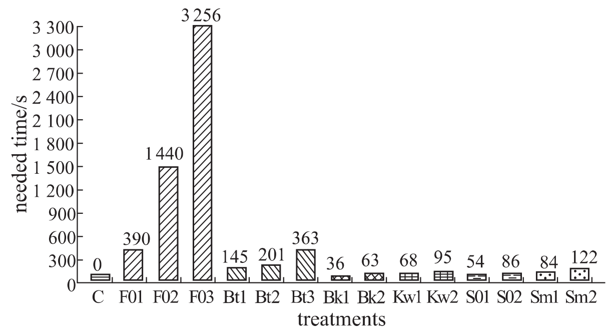

Figure 5. Effects of soil conditioners on needed time for complete disaggregation.

respectively.

Bitumen emulsion also decreases disaggregation rates in its treatments which reach -10.8×10^{-3}, -8.6×10^{-3} and -6.4×10^{-3} for its three levels of spraying, in other words, reducing the disaggregation rates by 1.9, 2.4 and 3.3 times in comparison with control treatment. Decrease in disaggregation rates is accompanied with the increase in spraying levels.

Disaggregation rates decrease due to the increase in soil aggregation and the stability of the aggregates. Bitumen emulsion has sticky nature that lets it connect and join soil particles and form the soil aggregates (De Boodt, 1972). Plant residuals decrease the disaggregation rates and their effects are in the third place after fuel oil and bitumen emulsion. Disaggregation rates in their treatments reach -14.9×10^{-3}, -14.6×10^{-3}, -14.6×10^{-3} and -13.3×10^{-3} for the second levels of Bakaz, Kawaleh, Sus and Supermos.

Statistical analysis indicates negative high correlation ($r=0.961^{**}$) between disaggregation rate and mean weight diameter. There is also a negative high correlation ($r=-0.971^{**}$) between disaggregation rates and the percentage of dry aggregates (>0.84 mm).

Generally, soil conditioners increase the needed time for disaggregation as shown in Fig. 5 where that fuel oil treatments surpass all treatments in increasing the needed time for complete disaggregation of dry aggregates.

Fuel oil treatments need 390, 1 440 and 3 256 for three levels of those treatments respectively for the complete disaggregation of the dry aggregates. The increase in the needed time is due to the nature and characteristics of fuel oil material, which has a sticky behavior.

The results also show that bitumen emulsion treatments are in the second place in increasing the needed time for complete disaggregation. Those treatments in the first, second and third levels needed 145, 201 and 363 for complete disaggregation.

The effects of plant residuals are slight in increasing the needed time for complete disaggregation. There is a big difference between its effects and the effects of oil derivatives, especially fuel oil. Statistical analysis shows a positive high correlation ($r=0.975^{**}$) between the needed time and mean weight diameter, and a positive high correlation ($r=0.996^{**}$) between the needed time and the percentage of dry aggregates.

Effects of Soil Conditioners on Bulk Density and Porosity

The results of this study indicate as shown in Fig. 6 that the fuel oil treatments (especially in the first and second levels) decrease the bulk density of surface layer of sand dunes, and their effects are highly and statistically significant. It reaches 472 and 1 508 kg/m^3 respectively, while it is 1 601 kg/m^3 for the control treatment.

The three levels of fuel oil treatments decrease the bulk density by 8.1 %, 5.9 %, and 2.7 % respectively. Its most important effect is in the first level of mulching, which is due to the improvement of aggregation formation and structure and the increase in porosity percentage as well.

Figure 7 shows that the first level of fuel oil treatments increase the total porosity, it reaches 11.9 % in comparison with control treatment, while it reaches 8.6 % and 4.0 % for the second and the third levels respectively. The effects are high and statistically significant in the first and the second levels, while it is not significant in the third level. The

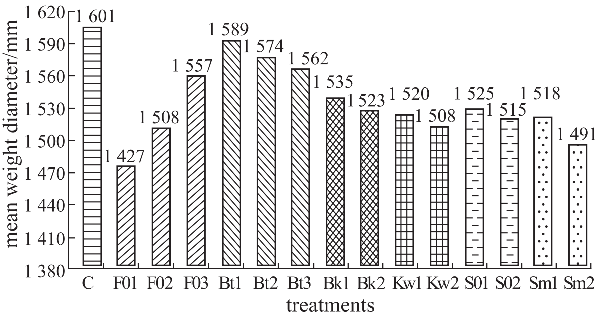

Figure 6. Effects of soil conditioners on bulk density.

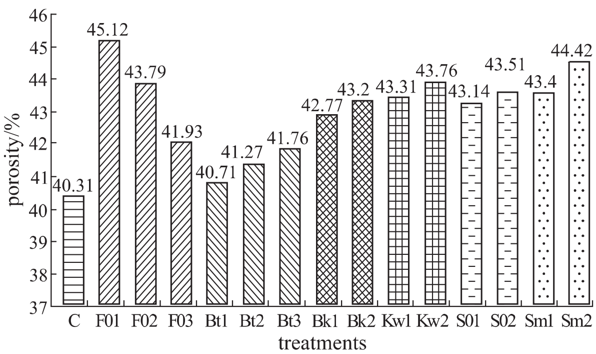

Figure 7. Effects of soil conditioners on porosity.

decrease in the total porosity and the increase in the bulk density values with the increase of fuel oil mulching levels are due to the nature of that material whereas cause to close the pores (Emerson, 1959). The results of this study show that the effect of bitumen emulsion is not significant statistically. We can refer that to the method of its spraying as a mulch. The plant residuals decrease bulk density, and there is no big difference among its effects.

DISCUSSION

The study's results indicate that the used conditioners have not the same effects on the natural vegetation cover, where the effect of oil derivatives is negative and does harm to natural vegetation cover, while the effect of plants residuals is positive.

Oil derivatives, espically fuel oil, decrease the natural vegetation cover by large degree particularly at its second and third levels of spraying. That level prevents the growth of natural vegetation by large degree, which is due to the little moisture content in the treatments. So there was not enough water content which is necessary for emergence and growth of local weed seed. The fuel oil layer, which covers sand dunes surface, acts as obstacle against rainwater in its penetration into the soil; subsequently, the soil has not enough moisture content for the growth of weed seeds. These results agree with the results of Zak and Wagner (1967). This property of fuel oil (as inhibitor of vegetation cover) is not suitable for sand dunes stabilization because it prevents the water penetrating into the soil.

Bitumen emulsion also has a bad effect on natural vegetation cover albeit, and its effect is less than fuel oil's effect and this bad effect becomes stronger with increasing of mulching levels. Results indicate that the natural vegetation cover in the first level of bitumen emulsion treatment is much better than the second and the third levels treatments, which is due to the slight thickness of bitumen layer which covers sand dunes surface and does not prevent emergence of local plant's growth, while in the second and third levels of bitumen emulsion treatments, the layer is too thick and plays a bad role in inhibition of local plant growth owing to its hardness to be penetrated by emerging plant and rain water. Therefore, it reduces considerably the natural vegetation cover in those treatments, despite of the good moisture contents in it. Also observed, there are many new plants under the thick bitumen's layer that can't break that hard layer.

Plant residuals treatments generally have positive effects on the natural vegetation cover. They increase the organic matter in the soil, consequently, it improves soil structure, reduces bulk density and increases the pores and ultimately increases soil moisture.

REFERENCES CITED

Armbrust D V, 1977. A Review of Mulches to Control Wind Erosion. Trans ASAE, 20(5):904−910

Ben Salem B, 1985. Mulching Technique of Dune Fixation: The Layer System. In: Sand Dunes Stabilization, Shelterbelts, and Afforestation in Dry Zones. FAO Conservation Guide, (10):71−74

Black C A, Evans D D, White J L, et al, 1965. Methods of Soil Analysis. Part 1. Am Soc of Agron Inc

Chepil W S, 1950. Properties of Soil Which Influence Wind Erosion: Ⅱ. Dry Aggregates Structure a Index of Erodibility. Soil Sci, 69:403−414

Christensen B T, 1986. Straw Incorporation and Soil Organic Matter in Macro-Aggregates and Particle Size Separates. Soils and Fert Abs, 49(6):651

De Boodt M, 1972. Improvement of Soil Structure by Chemical Means. In: Hillel D, ed. Optimizing the Soil Physical Environment toward Greater Crop Yields. New York and London: Academic Press. 43−55

De Benito G A, 1974. Sand Dune Stabilization at El-Aaiun West Sahara. Int J Biometeor, 18(2):142−144

Dougrameji J S, 1979. Some Physical Properties of Sandy Soils and Sand Dunes in Iraq. FAO Soil bulletin No. 25, Rome, Italy

Dougrameji J S, Kaul R N, 1972. Sand Dunes Reclamation in Iraq—Present Status and Future Prospects. Annals of Arid Zone, 11(3,4):133—137

El-Hady O A, 1984. Criteria to Evaluate Soil Conditioners for Aggregates Formation and Wind Erosion Control. Egypt. J Soil Sci, 24(2):137—144

Emerson W W, 1959. Stability of Soil Crumbs. Nature, (183):538

FAO, 1993. International Convention to Combat Desertification in Those Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa. Rome, Italy

Jackson M L, 1958. Soil Chemical Analysis. Englenwood, Cliff, N J: Prentice-Hall Inc

Mitchell A, 1974. Plants and Techniques Used for Sand Dune Reclamation in Australia. Int J Biometeor, 18(2):168—173

Stevens J H, 1974. Stabilization of Aeolian Sands in Saudi Arabia's Al-Hasa Oasis. J Soil and Water Cons, 29(3):129—133

U S Salinity Laboratory Staff, 1954. Diagonsis and Improvement of Saline and Alkali Soils USDA Handbook No, 60, Washington D. C.

Youker R E, McGuinness J L, 1957. A Short Method of Obtaining Mean Weight Diameter. Soil Sci, 83:291—294

Zak J M, Wagner J W, 1967. Oil-Base Mulches and Terraces as Aids to Tree and Shrub Establishment on Coastal Sand Dune. J Soil and Water Cons, 22:198—201

* * * * * * * * * * *

(**continued from page 57**)

Li D, Cao Z, Qin G, et al, 1998. Gold Deposits in Ailaoshan Ophiolitic Melange Zone. Beijing: Geological Publishing House

Tang S, Li J, 1991. Preliminary Studies of Mineralization Law in Northern Ailaoshan. Yunnan Geology, 10(1):22—26

Deng J, Yang L, Zhai Y, 2000. Theoretical Framework and Ethodological System of Tectonics-Fluids-Mineralization System and Dynamics. Earth Science—Journal of China University of Geosciences, 25(1):71—7

Xu Z, 1994. Study on Hydrogeochemistry of Mineralizing Solution of the Zhenyuan Au Deposit: [Dissertation]. Chengdu: Chengdu University of Technology

Zhang Z, Zhang W, 1999. Investigation into Metallogenic Fluid Feature in Carlin Type Gold Deposits and Its Relation to Mineralization in Southwest Guizhou Province. Earth Science—Journal of China University of Geosciences, 24 (1):74—78

View publication stats