**Analysis of OsCaR flume measurements on defaunated sediment**

Loading datafiles

close all

clear variables

cd('Defaunated');

umax = load('umax.txt')./100; % umax in m/s

umax = umax(:,1);

amax = load('amax.txt')./100; % amax in m

load('sediment.txt'); % col 1 = site; col 2 = D50; col 3 = mud %, col 4 = D50,sand, col 5 = D90

**Calculate bed shear stress from critical velocity**

ks = 2.5.\*sediment(:,2)./1e6;

ks(ks<0.001) = 0.001;

a = 0.0076;

fw = a.\*amax.^-0.52;

BSS = 0.5.\*1025.\*fw.\*(umax(:,1)).^2; % critical BSS - waves

**Calculate bed shear stress from theory of Wu et al., 2018**

First, we calculate from theory the critical shear stress of the mud fraction

Mudprc = sediment(:,3); % mud concentration (%)

drydens\_mix = 1000; % dry density of sediment mixture

drydens\_sand = 1620; % dry density of sand fraction

rho\_particle = 2650; % particle density

p\_mud = sediment(7,3)./100; % relative mud concentration

p\_sand = 1-p\_mud; % relative sand concentration

B = 0.65; % filling factor (-)

drydens\_mud = p\_mud/((1/drydens\_mix)-((p\_sand/rho\_particle)\*B)-((p\_sand/drydens\_sand)\*(1-B))); % dry density of mud fraction

porosity\_mud = 1-(drydens\_mud/rho\_particle); % porosity of mud fraction

solvo = (1-porosity\_mud)/porosity\_mud; % solid/void volume ratio of mud fraction

BSS\_mud = 10.29.\*solvo^1.7

The theoretical critical shear stress of the mudy sediment is similar to what was observed, so we use this to calculate the critical bed shear stress for the sand - mud mixtures.

R = 1.65; % suspended sediment density

g = 9.81; % gravitational acceleration

v = 1e-6; % viscosity

Mudcr = 0.05; % critical mud content for Wu equations

Mudprcline = [0:1:100];

Dstar\_sand = (sediment(8,2)./10^6).\*((g.\*R)./v^2).^(1/3); % nondimensional grain size of sand fraction

thetacr\_sand = (0.30./(1+1.2.\*Dstar\_sand))+0.055.\*(1-exp(-0.02.\*Dstar\_sand)); % Shields number

BSS\_sand = thetacr\_sand.\*R.\*1027.\*g.\*(sediment(8,2)./10^6);

BSS\_mud0 = 1.9; % critical BSS estimate for pure consolidated mud

alpha = 0.42.\*exp(-3.38.\*(340./10^6).\*1027);

BSS\_wu = (BSS\_sand+1.25.\*(BSS\_mud-BSS\_sand).\*min(Mudprcline./100,Mudcr))+(BSS\_mud-(BSS\_sand+1.25.\*(BSS\_mud-BSS\_sand).\*min(Mudprcline./100,Mudcr))).\*exp(-alpha.\*((1-(Mudprcline./100))./(Mudprcline./100)).^1.2);

We can use this to calculate the theoretical shear stress corresponding to the measurements, to obtain the r-squared.

%Calculate critical BSS for measurements using Wu 2018

Dstar\_sand = (sediment(8,2)./10^6).\*((g.\*R)./v^2).^(1/3); % nondimensional grain size of sand fraction

thetacr\_sand = (0.30./(1+1.2.\*Dstar\_sand))+0.055.\*(1-exp(-0.02.\*Dstar\_sand)); % Shields number

BSS\_sand = thetacr\_sand.\*R.\*1027.\*g.\*(sediment(8,2)./10^6);

alpha = 0.42.\*exp(-3.38.\*(340./10^6).\*1027);

phase1 = BSS\_sand+1.25.\*(BSS\_mud-BSS\_sand).\*min(Mudprc./100,0.1);

BSS\_wu\_measured = phase1+(BSS\_mud-phase1).\*exp(-alpha.\*((1-(Mudprc./100))./(Mudprc./100)).^1.2);

[r,~] = corrcoef(BSS,BSS\_wu\_measured);

rsq\_wu = r(1,2)^2;

**Calculate critical bed shear stress from van Ledden 2003**

beta = 1; % an empirical factor

Mudfrac = Mudprcline./100;

Mudcr = 0.2; % critical mud content for onset cohesion

for i = 1:length(Mudfrac)

if Mudfrac(i) < Mudcr

BSS\_ledden(i) = BSS\_sand.\*(1+Mudfrac(i)).^beta;

elseif Mudfrac(i) >= Mudcr

BSS\_ledden(i) = ((BSS\_sand.\*(1+Mudfrac(i)).^beta-BSS\_mud)./(1-Mudcr)).\*(1-Mudfrac(i))+BSS\_mud;

end

end

Mudfrac = Mudprc./100;

for i = 1:length(Mudfrac)

if Mudfrac(i) < Mudcr

BSS\_ledden\_measured(i) = BSS\_sand.\*(1+Mudfrac(i)).^beta;

elseif Mudfrac(i) >= Mudcr

BSS\_ledden\_measured(i) = ((BSS\_sand.\*(1+Mudfrac(i)).^beta-BSS\_mud)./(1-Mudcr)).\*(1-Mudfrac(i))+BSS\_mud;

end

end

[r,~] = corrcoef(BSS,BSS\_ledden\_measured');

rsq\_ledden = r(1,2)^2;

# **Assessment**

figure;

p1 = plot(Mudprc,BSS,'.k','Markersize',10);

hold on

p2 = plot(Mudprcline,BSS\_wu,'-k','color',[0.7 0.7 0.7]);

p3 = plot(Mudprcline,BSS\_ledden,'--k','color',[0.7 0.7 0.7]);

xlabel('% Mud')

ylabel('\tau\_{cr} (N m^{-2})')

text(25,2.2,['R^2 = ',num2str(rsq\_wu,2)])

text(65,1.2,['R^2 = ',num2str(rsq\_ledden,2)])

legend([p1,p2,p3],'measured','Wu et al., 2018','Van Ledden, 2003')

legend BOXOFF

set(gca,'box','off')