
(geostatistics)

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E-mail: akhavan@rifr-ac.ir

(ETHz)

() () ()
(.) ()
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()

(geostatistics)

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(regionalized variable)

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) ()
(

(Kriging)

Guibal
Marbeau
Duplat
Houiller
Jost
Gunnarsson
Mandallaz

Matheron
Krige

(Double kriging)

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(blackforest)

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(.)

(.)

(.)

Tuominen
Nieschulze

(semi- variance)

$$\hat{\gamma}(h)$$

(Lag) h

N

x

$$Z(x_i)$$

$$Z(x)$$

i

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(regionalized variable)

(spatial structure)

(.)

(anisotropic)

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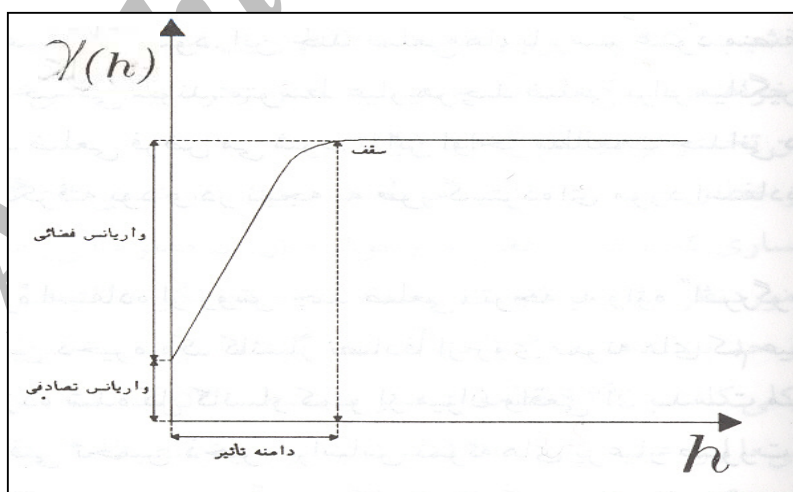
(isotropic)

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$$\hat{\gamma}(h) = \frac{1}{2N(h)} \sum_{i=1}^{N(h)} [z(x_i) - z(x_i + h)]^2$$



(h=0)

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(interception)

(nugget effect)

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(ordinary kriging)

(block kriging)

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)

(model dependent

(lag)

(spherical)

(sill)

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$$\hat{\gamma}(h) = c_0 + c \left[\frac{3}{2} \left(\frac{h}{a} \right) - \frac{1}{2} \left(\frac{h}{a} \right)^3 \right] \quad 0 \leq h \leq a$$

(range)

: C

: C₀

: a

(BLUE)¹²

Cross- validation

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$$\hat{z}(x) = \sum_{i=1}^n \lambda_i z(x_i)$$

()

: λ_i

: n

:

$$E[\hat{z}(x) - z(x)] = 0 \Rightarrow \sum_{i=1}^n \lambda_i = 1$$

$$E[\hat{z}(x) - z(x)]^2 = \min$$

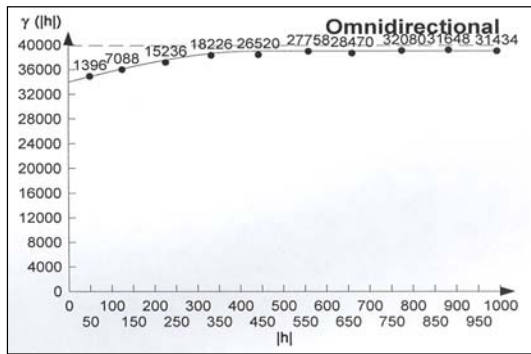
Best Linear Unbiased Estimator

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 : ()
)
 .(/

<i>p</i>	CV%					
/	% /	/	/	/	/	m ³ /ha

p=

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()
 (: h) ()

(transformation)

(/ : / :)

)
 /
 /
 (nugget effect)

Variowin 2.21

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Lag	(m)	(m)	(m ³ /ha) ²	(m ³ /ha) ²	

(geometric anisotropy)

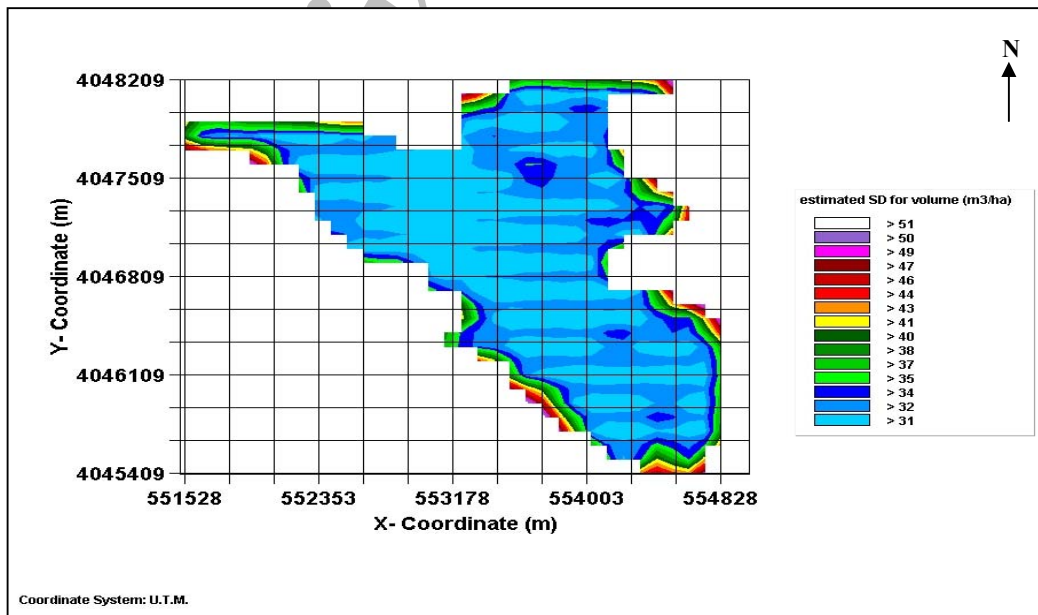
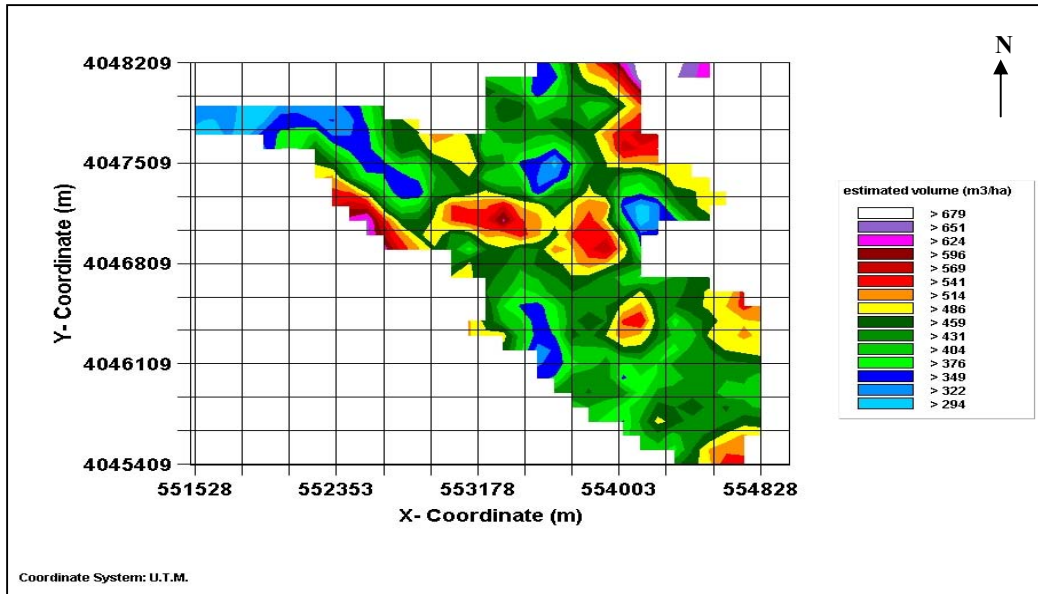
(zonal anisotropy)

(omni-directional)

Structured Part = (Sill- Nugget effect/ Sill) × 100

Gs⁺ 5.3b

() *



(:)

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:

(MAE)

(MSDR)

(MBE)

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MAE (m ³ /ha)	MBE (m ³ /ha)	MSDR	$\sigma(x)$ (m ³ /ha)
/	/	/	/

(MAE MBE)

$$MAE = \frac{1}{n} \sum_{x=1}^n |\hat{z}(x) - z(x)|$$

$$MBE = \frac{1}{n} \sum_{x=1}^n [\hat{z}(x) - z(x)]$$

$$MSDR = \frac{1}{n} \sum_{x=1}^n \left[\frac{\hat{z}(x) - z(x)}{\sigma(x)} \right]^2$$

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MSDR

x

: $\hat{z}(x)$

:n

(RMSE)⁴ x

: $\sigma(x)$

$$\sigma(x) = \sqrt{\frac{1}{n} \sum_{x=1}^n [\hat{z}(x) - z(x)]^2}$$

MBE MAE

(under estimate)

(over estimate)

MSDR

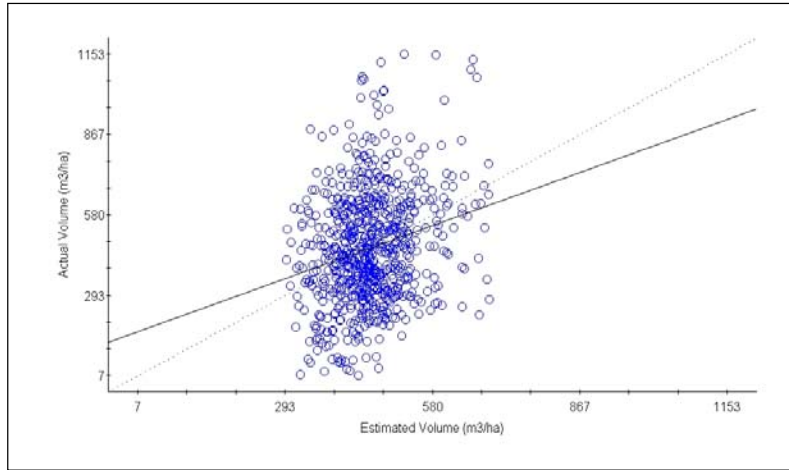
Mean Absolute Error

Mean Bias Error

Mean Squared Standardized Deviation Ratio

(Variance of standardized error)

Root Mean Squared Error



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($p = 1$)

(Periodic)

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Gunnarsson ()

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Tuominen ()

Jost () Guibal ()

Nieschulze ()

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P. Bachmann

(ETHz)

(

local estimation)

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Spatial Structure and Estimation of Forest Growing Stock Using Geostatistical Approach in the Caspian Region of Iran

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Abstract

In order to investigate on the spatial structure and estimation of forest growing stock in the Caspian region using geostatistical approach, this study was carried out in the Educational and Research Forest Station of Tehran University, Kheyroodkenar- Noshahr. Field sampling was performed, based on a 150m by 200m systematic rectangular grids. Since geostatistical techniques basically, rely on good estimates of spatial auto-correlation, particularly at short distances, four sample plots were taken 50m away, from central sample plots in the W-E and N-S directions. Each sample plot contained two concentric circles with areas of 300m² and 700m². Overall, 721 sample plots were inventoried in total area of 502 hectares. Then experimental variogram was calculated and plotted using the geo-referenced inventoried sample plots. The variogram revealed more than 80% Nugget effect, implying weak spatial auto- correlation between samples, even in 50m distances. Estimation was performed by ordinary block (100×100 m) Kriging using spherical model. Cross- validation results indicated that all the estimations are biased because of the large Nugget effect in the experimental variogram. Therefore, Kriging couldn't make a precise estimation due to large variability in short distances and the weak spatial structure of forest growing stock in this heterogeneous and uneven-aged forest.

Keywords: Geostatistics, Growing stock, Kriging, Spatial structure, Variogram.

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