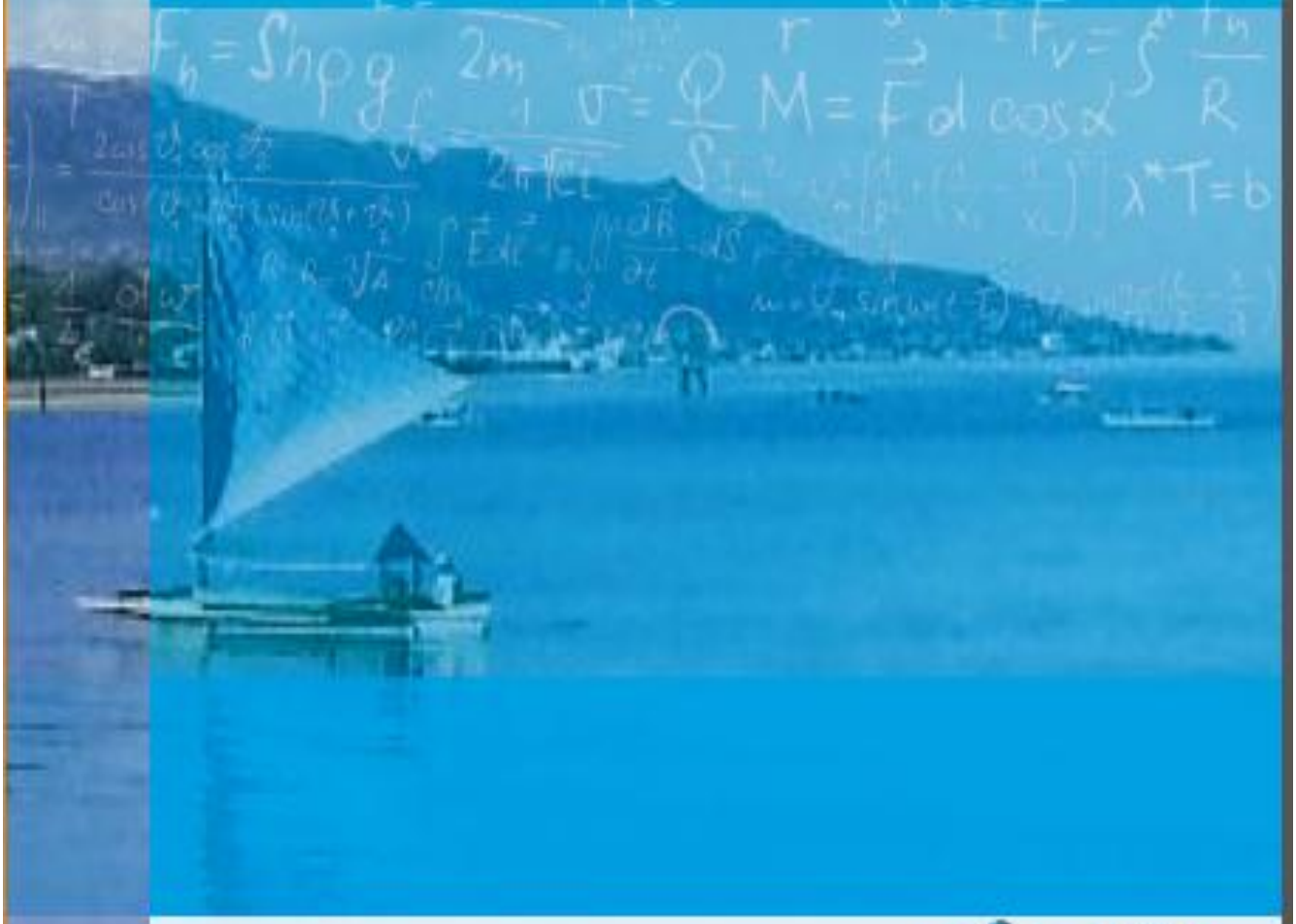
Basic Science
for Sustainable Marine Development

PROCEEDING
INTERNATIONAL SEMINAR 2015

Ambon, 3-4 June 2015



Organized by
Faculty of Mathematics and Natural Sciences
Pattimura University

PROCEEDINGS

1st International Seminar of Basic Science, FMIPA Unpatti - Ambon
June, 3rd – 4th 2015

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Welcoming Address by The Organizing Committee

The honorable, the rector of Pattimura University

The honorable, the vice rector of academic affair, Pattimura University

The honorable, the vice rector of administration and financial affair, Pattimura University

The honorable, the vice rector of planning, cooperation and information affair, Pattimura University

The honorable, all the deans in Pattimura University

The honorable, the key note speakers and other guests.

We have to thank The Almighty God for the blessings that allow this International seminar can be held today. This is the first seminar about MIPA Science in which the Faculty of MIPA Pattimura University becomes the host. The seminar under the title Basic Science for Sustainable Marine Development will be carried out on 3 June 2015 at Rectorate Building, the second floor. There are 250 participants from lecturers, research institute, students, and also there are 34 papers will be presented.

This International seminar is supported by the amazing people who always give financial as well as moral supports. My special thanks refer to the rector of Pattimura University, Prof. Dr. Thomas Pentury, M.Si, and the Dean of MIPA Faculty, Prof. Dr. Pieter Kakissina, M. Si. I also would like to express my deepest gratitude to Dr. Kotaro Ichikawa, the director of CSEAS Kyoto University, Prof. Bohari M. Yamin, University of Kebangsaan Malaysia, Prof. Dr. Budi Nurani Ruchjana (Prisident of Indonesian Mathematical Society/Indo-MS), Dr. Ir. A. Syailatua, M.Sc (Director of LIPI Ambon), and Hendry Ishak Elim, PhD as the key note speakers. We expect that this international seminar can give valuable information and contribution especially in developing basic science for sustainable marine development in the future.

Last but not least, we realize that as human we have weaknesses in holding this seminar, but personally I believe that there are pearls behind this seminar. Thank you very much.

Chairman

Dr. Netty Siahaya, M.Si.

Opening Remarks
By Dean of Mathematic and Natural Science Faculty

I express my deepest gratitude to The Almighty God for every single blessing He provides us especially in the process of holding the seminar until publishing the proceeding of International Seminar in celebrating the 17th anniversary of MIPA Faculty, Pattimura University. The theme of the anniversary is under the title Basic Science for Sustainable Marine Development. The reason of choosing this theme is that Maluku is one of five areas in Techno Park Marine in Indonesia. Furthermore, it is expected that this development can be means where the process of innovation, it is the conversion of science and technology into economic value can be worthwhile for public welfare especially coastal communities.

Having the second big variety of biological resources in the world, Indonesia is rich of its marine flora and fauna. These potential resources can be treated as high value products that demand by international market. Basic science of MIPA plays important role in developing the management of sustainable marine biological resources.

The scientific articles in this proceeding are the results of research and they are analyzed scientifically. It is expected that this proceeding can be valuable information in terms of developing science and technology for public welfare, especially people in Maluku.

My special thanks refer to all researchers and reviewers for your brilliant ideas in completing and publishing this proceeding. I also would like to express my gratefulness to the dies committee-anniversary of MIPA Faculty for your creativity and hard working in finishing this proceeding, God Bless you all.

Dean of Mathematic and Natural Science Faculty

Prof. Dr. Pieter Kakisina, M.Si.

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Development on Theoretical and Application of Space Time Autoregressive Modeling

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ABSTRACT

In this paper, we studied the development study of space time modeling both of theoretical and applications, especially for the Generalized Space Time Autoregressive (GSTAR) with stationary and non-stationary data. The GSTAR is a special case of multivariate time series model Vector Autoregressive (VAR), with simultaneously combine time series and spatial analysis. We propose Generalized Space Time Integrated (GSTARI), Generalize Space Time Exogenous (GSTAR-X) using parameter estimation method of Ordinary Least Squares (OLS) and also Seemingly Unrelated Regression (SUR) using script of R software. For case study, we use the daily life phenomena in environmental, petroleum, consumer price index in Indonesia

Keywords *: GSTAR, GSTAR-Kriging, GSTARI, GSTAR-X, OLS, SUR, MAPE*

INTRODUCTION

The space time models are part of stochastics processes which is combine a time series and spatial analysis. The space time models such as Space Time Autoregressive (STAR) from Cliff-Ord (1975) and Pfeifer (1979) assumed that the locations have a homogenous characteristic. Ruchjana (2002) extend the STAR to be a Generalized STAR (GSTAR) which assumed that each locations has a different parameters, so the characteristic of location are heterogenous. The STAR and GSTAR models are important to study both of theory and applications. For theoretical work we studied a development of space time models in modeling and parameter estimation (Ruchjana, 2014)

DEVELOPMENT OF GSTAR MODEL

Ruchjana (2002) proposed the GSTAR order one both of space and time is stated:

$$\mathbf{z}(\mathrm{t}) = \sum_{\mathrm{k}=1}^{1} \sum_{\ell=0}^{\lambda_1} \Phi_{\mathrm{kl}}\, \mathbf{W}^{(\ell)}\, \mathbf{z}(\mathrm{t}-\mathrm{k}) + \mathbf{e}(\mathrm{t}) \tag{1}$$

or we can write as following:

$$\begin{aligned} \mathbf{z}(t) &= \Phi_{10}\mathbf{W}^{(0)}\mathbf{z}(t-1) + \Phi_{11}\mathbf{W}^{(1)}\mathbf{z}(t-1) + \mathrm{K} + \Phi_{1\lambda_1}\mathbf{W}^{(\lambda_1)}\mathbf{z}(t-1) + \mathbf{e}(t) \\ \mathbf{z}(t) &= \Phi_{10}\mathbf{I}_N\mathbf{z}(t-1) + \Phi_{11}\mathbf{W}^{(1)}\mathbf{z}(t-1) + \mathrm{K} + \Phi_{1\lambda_1}\mathbf{W}^{(\lambda_1)}\mathbf{z}(t-1) + \mathbf{e}(t) \end{aligned} \tag{2}$$

The GSTAR(1;1) model is a special case of Vectoe Autoregressive (VAR) order one model, so we can notify the model as below:

$$\mathbf{z}(\mathrm{t}) = \Phi_{10}\mathbf{z}(\mathrm{t}-1) + \Phi_{11}\mathbf{W}^{(1)}\mathbf{z}(\mathrm{t}-1) + \mathbf{e}(\mathrm{t}) \tag{3}$$

with the assumption:

$\mathbf{\Phi}_{10}$: diagonal matrices containing the autoregressive parameter at time lag 1
$\mathbf{\Phi}_{11}$: diagonal matrices containing the space-time parameter at spatial lag 1 and time lag 1
$\mathbf{z}(t)$: the random vector of observation at time t
$\mathbf{W}^{(1)}$: the weight matrix at spatial lag 1
$\mathbf{e}(t) \sim$ iid $(\mathbf{0}, \sigma^2\mathbf{I}_N)$

We can use an Ordinary least Square (OLS) method to estimate the parameters of GSTAR, because from the equation (3) we knew that the GSTAR has a linear model form. The OLS for GSTAR can be derived using linear model form:

$$\mathbf{z}(t) = \underbrace{\begin{bmatrix} \text{diag } \mathbf{z}(t-1) & \text{diag } \mathbf{V} \end{bmatrix}}_{\mathbf{x}_{G2}} \begin{pmatrix} \phi_{10}^{(1)} \\ \vdots \\ \phi_{10}^{(N)} \\ \phi_{11}^{(1)} \\ \vdots \\ \phi_{11}^{(N)} \end{pmatrix} + \mathbf{e}(t)$$

$$\text{where} \quad \mathbf{V} = \begin{pmatrix} \sum_{j=1}^{N} w_{1j}^{(1)} z_j(t-1) & 0 & \cdots & 0 \\ 0 & \sum_{j=1}^{N} w_{2j}^{(1)} z_j(t-1) & \cdots & 0 \\ \vdots & 0 & \cdots & 0 \\ 0 & 0 & \cdots & \sum_{j=1}^{N} w_{Nj}^{(1)} z_j(t-1) \end{pmatrix} \tag{4}$$

In the development of GSTAR model, we propose to combine simultaneously an endogenous and exogenous variables in the space time model, we called GSTAR-X. For this model we should have a high correlation coefficient between endogenous and exogenous variables. Furthermore, the equation (3) can be developed to be equation (5):

$$\mathbf{z}(t) = \Phi_{10}\mathbf{z}(t-1) + \Phi_{11}\mathbf{W}^{(1)}\mathbf{z}(t-1) + X(t) + \mathbf{e}(t) \tag{5}$$

We also propose a Seemingly Unrelated Regression (SUR) to estimate the parameters of GSTAR model to extend a homoscedasticity to be a heteroscedasticity assumptions. Using OLS method we have assumption there is no autocorrelation between error at time t for all locations, but using SUR method the error have autocorrelation assmption in space and time. We can write the variance error for OLS and SUR as following (Iriany, *et al.*, 2013):

OLS

$$Var(\boldsymbol{\varepsilon}) = \mathbf{I}\sigma^2 = \begin{pmatrix} \sigma^2 & 0 & 0 & 0 & 0 \\ 0 & \sigma^2 & 0 & 0 & 0 \\ 0 & 0 & \sigma^2 & 0 & 0 \\ 0 & 0 & 0 & \sigma^2 & 0 \\ 0 & 0 & 0 & 0 & \sigma^2 \end{pmatrix}$$

SUR

$$Var(\boldsymbol{\varepsilon}) = \Omega = \begin{pmatrix} \sigma_{11} & \sigma_{12} & \sigma_{13} & \sigma_{14} & \sigma_{15} \\ \sigma_{21} & \sigma_{22} & \sigma_{23} & \sigma_{24} & \sigma_{25} \\ \sigma_{31} & \sigma_{32} & \sigma_{33} & \sigma_{33} & \sigma_{35} \\ \sigma_{41} & \sigma_{42} & \sigma_{43} & \sigma_{44} & \sigma_{45} \\ \sigma_{51} & \sigma_{52} & \sigma_{53} & \sigma_{54} & \sigma_{55} \end{pmatrix}$$

Another development of GSTAR models is a GSTAR-Kriging (Ruchjana and Darwis, 2007), and an implementation of spatio temporal data mining using Clustering GSTAR-Kriging (collaboration research with Researcher from Faculty of Spatial Sceinces University of Groningen and LAPAN Bandung), also a development of GSTARIMA-X based on transfer function and econometrics approach (Collaboration with researchers from IPB and ITS).

SOME APPLICATIONS

GSTAR model and its development can be implemented to real data at various field, such as: tea productivity data (Borovkova, *et al.*, 2008), oil production data (Ruchjana, 2002), Ruchjana and Darwis (2007), (Ruchjana, *et al.*, 2013), climate change phenomena (Iriany, *et al.*, 2013) and Clustering Spatial GSTAR model (Ruchjana, *et al*., 2013). Furthermore we propose the Spatio Temporal Data Mining using Clustering GSTAR-Kriging (Ruchjana, et al. 2014) based on studied of Abdullah (2009) and Abdullah, *et al*. (2013).

SUMMARY

In this paper we explain the development of space time model both of theoretical and applications, especially for the GSTAR model to be the GSTAR-X, GSTARI, GSTAR-Kriging, and spatio temporal data mining approach using clustering GSTAR-Kriging (Ruchjana, *et al.,* 2014).

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