



Biomath Communications

www.biomathforum.org/biomath/index.php/conference

The bio-mathematics Chair at University of Pretoria in 2015¹

M. Chapwanya, J. M-S. Lubuma

University of Pretoria, Department of Mathematics and Applied

Mathematics, Pretoria 0002, South Africa

m.chapwanya@up.ac.za, jean.lubuma@up.ac.za

Keywords: Research Chair, progress report, University of Pretoria.

Abstract

In this report we summarize the activities and achievements of the Bio-mathematics Chair at the University of Pretoria in 2015.

1 Introduction

The SARChI (South African Research Chairs Initiative) was established in 2006 as a strategic intervention of the Department of Science and Technology (DST), South Africa, that is managed by the National Research Foundation (NRF). From here forthwith, now referred to as DST/NRF SARChI Chair. As stated in their initial proposal, the SARChI is intended to reverse brain drain in the public academic and research sector and increase scientific research capacity through the development of human capacity and stimulating the generation of new knowledge, [4].

¹**Citation:** M. Chapwanya, J. Lubuma, The bio-mathematics Chair at University of Pretoria in 2015. Biomath Communications 2/2 (2015) <http://dx.doi.org/10.11145/586>

The DST/NRF SARChI Chair in Mathematical Models and Methods in Bioengineering and Biosciences, commonly referred to with the acronym M³B² was formally launched in October 2013 at the University of Pretoria (UP). Since then, it has grown from strength to strength. We can proudly state that the SARChI Chair M³B² is an effective and operational research unit that meets international standards and compares well with similar entities in the world. It has quickly become an environment in which research activities/projects and postgraduate education are supported and can flourish. The objectives of the Chair is to serve as a multidisciplinary platform for both mathematicians and biologists who are interested in forming mathematical models and solving model equations of biological processes and systems that are testable in the real world, [2].

Support for multidisciplinary research is at the forefront of the SARChI Chair's objectives. The current principal investigators present a good balance between Mathematicians (both pure and applied), Biologists, Zoologists, Entomologists, Epidemiologist, among others. The principal investigators and postdoctoral fellows steer the Chair research activities through supervision of postgraduate students. In 2015 it was home to 10 principal investigators, 3 postdoctoral fellows, 4 PhD students, 6 MSc students and 3 Honors students. These students are fully or partially funded by the Chair.

2 Research

The research focus of the Chair, M³B² lies at the intersection of mathematical modelling of biological processes and a spectrum of mathematical specializations, broadly located within analysis. The biological processes to be considered within the Chair are highly relevant to the needs of the country. These include mathematical epidemiology, specifically the identification of adequate scientific, engineering or medical responses to new diseases and old forms of new diseases, such as malaria, tuberculosis, cancer, HIV/Aids and other communicable diseases that pose a massive threat to development in South Africa and beyond.

Currently, the Chair has 3 main focus areas: modeling with advection-

reaction partial differential equations with diffusion and/or cross-diffusion, dynamics of some compartmental epidemic models and trends in the mathematical modelling of the HIV/AIDS with impact on its control. Significant contributions have been achieved in areas such as scientific computing [8], biomediation and biofilms [12, 18, 11, 6], production and transmission of queen honeybee pheromone [16, 19], pattern formation [7], dynamics of compartmental models with strong Allee effect [17], age structure models for measles with vaccination, treatment and hospitalization, delay differential equations for vector-borne diseases [13], Volterra integral equations [15].

In 2015, we are proud to announce that some of the goals in the initial proposal were achieved with 3 PhD students completing, and 2 MSc students expected to complete their studies in February 2016. This was possible, despite changes within the Chair holder, Prof Jean Lubuma taking a new position as the Dean of Faculty of Natural and Agricultural Sciences (UP) from May 2015, and Dr Michael Chapwanya as interim Chair for the remainder of the year. Prof Jacek Banasiak was appointed new Chair holder from 2016. In particular, the performance of the Chair was not affected because the research and the initiatives have very strong grounding and support in the Department and the University.

3 Visibility

3.1 Conferences

The Chair was involved as a partner or main organizer of in 3 conferences in 2015. These are the South African Symposium on Numerical and Applied Mathematics (SANUM) 2015 [5], the Second University of South Africa (UNISA) – University of Pretoria (UP) Workshop [3], and the BIOMATH2015 Satellite international conference, [1].

As a partner, in organizing the SANUM 2015 conference, the Chair had a special session on Mathematical Biology. The guest lecture was given by Prof. A. Gumel of Arizona State University on the role on climate change on vector-borne diseases.

The Second UNISA-UP Workshop held in March 2015, organized and hosted by the Chair under the series name, Joint UNISA-UP Workshop on Theoretical and Mathematical Epidemiology, aimed to strengthen integration and cross-discipline collaborations, [9]. The Workshop sessions were conducted by internationally reputable experts in the areas of Mathematical Epidemiology visiting from countries as far as Canada and USA. A follow-up Mini UNISA-UP meeting was held in June 2015 with the aim of reporting on the progress of the projects from the Second Joint UNISA-UP Workshop. Six of the projects are now published under University of Pretoria reports, one has already been published [14], while some are already submitted to special issues of the BIOMATH2015-S conference.

The BIOMATH2015-Pretoria International conference that took place in July 2015 highlights some of the achievements of the Chair on the international stage, [10]. This meeting, a satellite conference to the BIOMATH conferences in Bulgaria, attracted 40 participants from 6 countries and 9 South African institutions of higher learning. The strong emphasis of the meeting was to provide access and support to young scientists who develop and apply mathematical and computational tools to study phenomena in the broad fields of life sciences. In addition to the Young Scientist Function, the connection and emphasis on young scientists was reinforced with Mr Yibeltal Terefe presenting his PhD oral defense at the end of the conference.

3.2 Student activities

The first ever student Chapter of the American Society for Industrial and Applied Mathematics (SIAM) was approved in 2014 with the aim to provide visibility and a platform for students to share their ideas and enthusiasm in mathematical sciences. In 2015, the Chapter organized student-focused activities such as the Mathematics Writing Workshop, Postgraduate seminars, midterm and end of year functions, conference attendance and participating during the University of Pretoria Open Day, [2].

The Under Twenty Mathematician (UTM) is another exciting dimension under the Chair aimed at young scientists. The program aims to identify, recruit and groom young South Africans to become Mathemati-

cians. Training sessions, motivational talks and school visits are some of the activities in 2015 under the UTM.

3.3 Collaborations and Seminars

The Chair has a number of ongoing regular platforms where researchers share ideas and showcase their work. These meetings are the Biomath Forum Lecture Series, Seminar in Partial Differential Equations, their Numerical Analysis and Applied Mathematics (PDENAAM) and the Biomath Coffee. While the first two are more formal, the latter is less formal and offers a multidisciplinary platform for all researchers in life sciences. In 2015 we had 17 cross-discipline presentations under the Biomath Coffee seminar series. We also had 3 Biomath Forum lecture series with speakers from Israel, USA and France. A series of lectures under the title *Mathematical modelling and simulations in applied sciences*, were given in July 2015 by Prof. H. Kojouharov of University of Texas at Arlington.

While these activities have attracted some of the top researchers in the world, existing collaborations are strengthened with new collaboration platforms formed both locally and abroad. Notable among them are collaborations with the Centre of Mathematical Biology at Arizona State University (USA), Bulgarian Academy of Science (Bulgaria), and DST/NRF Centre of Excellence in Mathematical and Statistical Sciences (CoE-MaSS) at University of Witwatersrand (South Africa). In particular, the Chair is a partner and a node for the University of Pretoria within the CoE-MaSS. In 2015 the CoE-MaSS funded some of the activities of SANUM2015 and the Second UNISA-UP Workshop. Stronger collaboration with BIOMATH in Bulgaria has been reinforced over the years with several students funded to attend the BIOMATH2015.

4 Conclusion

The SARChI Chair M³B² is an effective and operational research unit that meets international standards and compares well with similar entities in

the world. It has quickly become an environment in which research activities/projects and postgraduate education are supported and can flourish.

Acknowledgements

The authors acknowledge the support of South African DST/NRF SARCHI Chair on Mathematical Models and Methods in Bioengineering and Biosciences (M³B²).

References

- [1] BIOMATH 2015-S (Pretoria). <http://www.up.ac.za/biomath2015-s>, 2015. Accessed: 2016-01-18.
- [2] DST/NRF SARCHI Chair in Mathematical Models and Methods in Bioengineering and Biosciences. <http://www.up.ac.za/sarchi-chair-m3b2>, 2015. Accessed: 2016-01-18.
- [3] Second UNISA-UP Workshop. <http://www.up.ac.za/unisa-up-workshop2015>, 2015. Accessed: 2016-01-18.
- [4] The South African Research Chairs Initiative (SARCHI). <http://www.nrf.ac.za/division/rcce/instruments/research-chairs>, 2015. Accessed: 2016-01-18.
- [5] South African Symposium on Numerical and Applied Mathematics. <http://www.sanum.co.za>, 2015. Accessed: 2016-01-18.
- [6] A. A. Aderogba and M. Chapwanya. An explicit nonstandard finite difference scheme for the allen–cahn equation. *Journal of Difference Equations and Applications*, 21(10):875–886, 2015.
- [7] R. Anguelov and H. M. D. Tenkam. Global stability of equilibrium of multi-species model with cross diffusion. In *Application of Mathematics in Technical and Natural Sciences: 7th International Conference for Promoting the Application of Mathematics in Technical and Natural*

Sciences-AMiTaNS'15, volume 1684, page 050001. AIP Publishing, 2015.

- [8] A. R. Appadu and S. N. N. Nguetchue. The technique of MIEELDL as a measure of the shock-capturing property of numerical methods for hyperbolic conservation laws. *Progress in Computational Fluid Dynamics, an International Journal*, 15(4):247–264, 2015.
- [9] M. Chapwanya. Breaking down the wall between mathematicians and biologists. http://www.up.ac.za/en/biomathforum/news/post_2053471-breaking-down-the-wall-between-mathematicians-and-biologists, 2015. Accessed: 2016-01-18.
- [10] M. Chapwanya. Bringing the BIOMATH network experience to South Africa. http://www.up.ac.za/en/mathematics-and-applied-mathematics/news/post_2143609-bringing-the-biomath-network-experience-to-south-africa, 2015. Accessed: 2016-01-18.
- [11] M. Chapwanya and N. N. Misra. A mathematical model of meat cooking based on polymer–solvent analogy. *Applied Mathematical Modelling*, 39(14):4033–4043, 2015.
- [12] M. Chapwanya and N. N. Misra. A soft condensed matter approach towards mathematical modelling of mass transport and swelling in food grains. *Journal of Food Engineering*, 145:37–44, 2015.
- [13] S. M. Garba, A. B. Gumel, A. S. Hassan, and J. M-S. Lubuma. Switching from exact scheme to nonstandard finite difference scheme for linear delay differential equation. *Applied Mathematics and Computation*, 258:388–403, 2015.
- [14] EF Doungmo Goufo and R Maritz. A note on ebola's outbreak and human migration dynamic. *Journal of Human Ecology*, 51(3):257–263, 2015.

- [15] J. M-S. Lubuma and Y. A. Terefe. A nonstandard volterra difference equation for the sis epidemiological model. *Revista de la Real Academia de Ciencias Exactas, Fisicas y Naturales. Serie A. Matematicas*, 109:597–602, 2015.
- [16] O. O. Okosun, A. A. Yusuf, R. M. Crewe, and C. W. W. Pirk. Effects of age and reproductive status on tergal gland secretions in queenless honey bee workers, *apis mellifera scutellata* and *a. m. capensis*. *Journal of Chemical Ecology*, 41, 2015.
- [17] S. Usaini, R. Anguelov, and S. M. Garba. Dynamics of si epidemic with a demographic allee effect. *Theoretical Population Biology*, 106:1–13, 2015.
- [18] H. F. Winstanley, M. Chapwanya, A. C. Fowler, and S. B. G. O’Brien. A 2d channel-clogging biofilm model. *Journal of Mathematical Biology*, 71:647–668, 2015.
- [19] A. A. Yusuf, C. W. W. Pirk, and R. M. Crewe. Mandibular gland pheromone contents in workers and queens of *apis mellifera adansonii*. *Apidologie*, 2015.