Vietnam : a case of military obsolescence in developing countries

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2018

Wu, S.-s. (2018). Vietnam : a case of military obsolescence in developing countries. The Pacific Review, 32(1), 113-130. doi:10.1080/09512748.2018.1428676

https://hdl.handle.net/10356/103295

https://doi.org/10.1080/09512748.2018.1428676

Table 1 the Comparison of Chinese and Vietnamese MBTs

Nationality	Types	Firepower: Main Gun	Mobility: Power-to-Weight Rate	Armour
Vietnam	T-62	115mm	14.5hp/ton	Steel
	T-55AM3	105mm	25hp/ton (Estimated)	Reactive
	T-55/54	100mm	14.44hp/ton	Steel
	Type-59	100mm	14.44hp/ton	Steel
China	Type 99	125mm	27.77hp/ton	Reactive with add-on module
	Type 98	125mm	25hp/ton	
	Type 96	125mm	24hp/ton	

Table 2 the Comparison of Chinese and Vietnamese Artillery Systems

Nationality	Type	Classification	Calibre	Maximal Range
Vietnam	M-107	Self-propelled Gun	175mm	32km
	2S3		152mm	18.5km
	2S1		122mm	15.3km
	M-101	Towed howitzer	105mm	11.2km
	M-102			11.5km
	Type-60		122mm	24km
	M-30			11.8km
	D-30			15.29km
	M-46		130mm	27km
	D-20		152mm	17.4km
	M-114		155mm	14.6km
	Type-63	Towed MRL	107mm	8.5km
	BM-21	Self-Propelled MRL	122mm	20.5km
	BM-24		240mm	16.8km
China	PLL-09	Self-Propelled Gun	122mm	18-27km
	PLZ-05		155mm	53km
	Type 83		152mm	17.23km
	Type 90	MRL	122mm	30km
	PHZ-89	MRL	122mm	30km
	PHL-03	MRL	300mm	150km

Table 3 the Comparison of Fighters between Vietnam and China's Southern Theatre Command

Fighter Generation	Vietnam	Guangzhou Military Region, China (Combined with PLAAF and PLANAF units)

3rd	Mig-21Bis/UM: 33; Su-22M/UM: 28	J-7s: 4 regiments and 1 brigade, about 150; J-8s: 1 regiment about 24
4th	Su-27SK/UBK: 11; Su-30MK2: 36	J-11/B (Su-27): 4 regiments, about 96; J-10: 2 regiments and one brigade about 72; Su-30MKK: 1 regiment about 24

Vietnam: A Case of Military Obsolescence in Developing Countries

Abstract

Military obsolescence affects the capability of all militaries as it relates to serviceability and performance when countering potential opponents, and more specifically for developing countries lacking strong indigenous defence industries. The gradual nature of this military concern has not been studied systematically, in contrast to military modernisation. This paper presents a synthetic framework composed of several indicators to examine military obsolescence. Vietnam has been selected for the application of the framework for its large number of Cold War legacies and the strategic pressure from China. Hanoi's ageing assets would undermine its position vis-à-vis Beijing, and its defence investment is faced with the dilemma of choosing to spend more on naval and aerial power, or ameliorate its army which is technologically lacking compared to its Chinese counterpart.

Introduction

In contrast to military modernisation, military obsolescence has equal, if not more, potential to destabilise the regional situation. All militaries have to deal with the unpleasant fact: all equipment is ageing from the first day of service, and ageing assets will eventually transform into obsolete ones without upgrades or replacement. Military obsolescence can affect war capacity, deterrence, defence diplomacy, operations other than war (OOTW), and even the safety of operators and other people. As military obsolescence weakens the balance of power between a state and its potential enemy, it also has impacts on defence diplomacy. Obsolete assets can pose technological obstructions for joint exercises, and reveal a state's poor defence management, thus potentially discouraging other countries from further cooperation. When operational readiness is questionable due to obsolescence, a military may fail to conduct OOTW well, and related accidents would pose threats to crews and nearby populations.

Such a situation becomes salient when potential enemies achieve better modernisation. An expanding gap of military capability among countries could undermine the stability, especially for developing countries mainly relying on foreign sources, of which Vietnam presents an example. Vietnam's military modernisation can be traced back to the Cold War. Although Hanoi received a lot of military supply, including sophisticated weapons, from Moscow and Beijing during the Vietnam War in order to counter the superior American military power, combat losses would have considerably eroded their capability. After the Vietnam War, the Soviet Union systematically supplied various military assets to Vietnam's three services, and many of them, such as BMP-2 infantry fighting vehicles (IFV), were

relatively advanced at the time. Hanoi also absorbed some American arms from its capture of Saigon (SIPRI 2017) (IISS 1979, 73-74). Simultaneously, related military doctrines were developed as well. (Thayer 2009, 5) Therefore, by the end of the Cold War, Vietnam's military had not technologically fallen behind its neighbouring counterparts, including that of China (IISS 1992, 145-147, 164-165).

In the post-Cold War era, limited financial capacity has constrained Hanoi's efforts in military modernisation. Vietnam's difficult economic transformation towards a market economy, along with the end of Soviet aid, restricted Hanoi's ability to afford military modernisation. As Hanoi pays attention to its maritime interests at present and Beijing expands its influence in the South China Sea, it is natural for the former to concentrate its limited investment of military modernisation on naval and aerial assets. Despite its significant military procurements in the last decade, Hanoi's arsenal, especially the land systems, is composed mainly of Cold War legacies. In contrast, Beijing has striven for military modernisation since its open policy of the 1980s, meaning that the People's Liberation Army (PLA) has achieved technological superiority over its Vietnamese counterpart. Vietnam's ageing military assets may have impacts similar to its new procurements on the regional security. As long as their intensive bilateral relations continue, the military imbalance between these two states may entice the stronger to use force against the weaker nation.

This paper will illustrate a synthetic framework for identifying military obsolescence, and analyse the case of Vietnam. This paper will contribute to the research on military modernisation by presenting another perspective.

The Synthetic Framework for Examining Military Obsolescence

Military obsolescence is usually neglected by academics and mass media that pay more attention to modernisation, including defence technology and procurement. It is reasonable for military build-ups to attract attention because technology within military acquisition usually refers to potential intention and capability to affect the status quo, as technological progression has significantly shaped warfare (Heitman 2004, 3-16; Tan 2014, 8-14). In contrast, although assets already in service would not have an immediate impact, their ageing would gradually erode a country's military capability, and then the status quo. Since obsolescence can be attributed to a lack of modernisation, the reasons behind obsolescence can be explained with research on military modernisation. Buzan and Herring's models of arms dynamics signify that military obsolescence is likely to occur in less competitive subjects and / or subjects beyond the interests of indigenous defence industries (Buzan and Herring 1998, 81-118). Horowitz's conditions for diffusion of military technology suggest that military obsolescence could reflect constrained financial intensity or lack of

organisational capacity. A comparison of the costs between adaption and non-adaption as well as political decisions could also reveal various factors behind military obsolescence (Horowitz 2010, 9-34). Regarding the nature of military obsolescence, Thomas points out that a country's level of military obsolescence depends on its potential enemy's capability. A country's military capability may become relatively obsolete due to its potential enemy's faster modernisation (Thomas 1986, 246-247). Uberoi also highlights obsolescence in a comparative way, but he also mentions the end of service life to be another reason of replacement (Uberoi 1989). Bitzinger provides another dimension of obsolescence: replacement for safety (Bitzinger 2010, 62). However, as noted by James, "a 100-year-old rifle is as effective as a modern equivalent," it appears that the means of identifying obsolete assets and the extent of obsolescence have not been sufficiently discussed (James 2016, 20). In sum, obsolescence can be defined the serious status of ageing, whereby a specific arm cannot operate its specific functions, whether due to poor operational readiness or inferior technological performance in contrast to potential opponents.

There is no universal standard of military obsolescence due to each country's unique internal and external characteristics as well as to a lack of research, but some indicators are useful for most developing countries when examining their considerable dependence on foreign arms sources. As one of the peacetime functions of a military is to maintain existing capability in a required state of readiness, the indicators for examining obsolescence are classified into two groups: readiness and comparison (Markowski, Hall and Wylie 2010, 26).

Readiness is the precondition for all armed forces both for warfare and OOTW; the related indicators are upgrade, service number, and external logistical availability. In fact, these three indicators would not provide precise information on the impact of obsolescence on readiness, but they are publicly available for research and analysis, as actual logistical data, such as readiness and operational costs, would be valuable for analysis but are classified. Upgrade refers to the rejuvenation of assets and indicates an investment in the extension of asset lifespan. Due to the generally weak industrial foundation of developing countries, foreign parts such as engines and radars are usually essential in upgrade projects to extend service life, and in most cases, such international transfers are systematically recorded in the database of the Stockholm International Peace Research Institute (SIPRI) (SIPRI 2017). Service numbers of assets, in contrast to numbers of introduction, would signify the overall maintenance during peacetime, and the International Institute for Strategic Studies (IISS)'s annual *Military Balance* provides valuable data for research. Dramatically decreasing numbers would mean potential difficulties in keeping assets in service and subsequently undermine a specific capability. Undeniably, dropping service numbers in many countries would not be easily shown, but they therefore highlight the significance of reduced service numbers.

Due to the limited indigenous industrial capacity, external logistical availability is usually crucial for developing countries, from both manufactures and overseas users. When a model of a military asset is still under production, its logistical support is likely to be available from its manufacturer, given sufficient financial affordability and no sanctions in force. The end of production does not however definitively terminate the logistical supply, and numbers of overseas users would suggest two means of availability. As some users may sell the model of assets and their parts, a number of users may form a market for non-original arms manufacturers to provide logistical support. If the number of users is too small, both approaches would be less likely to exist, and thus logistical challenges appear. In addition, when a particular weapon model is listed in many countries, particularly in its original country, it suggests that those users generally accept its performance and operational costs, so that they have both the willingness and capability to retain that model. In short, the popularity of assets refers to a common view of obsolescence and availability of logistic support.

Since the military does not operate in a vacuum, it is necessary to define military obsolescence by means of a comparison between a military and its potential challenges, whether internal or external. Although insurgencies usually have inferior military capability, various cases, such as man-portable system (MANPADS) in Afghanistan in the 1980s and improvised explosive devices (IED) in Iraq in the 2000s, demonstrate the possibility of technological challenges from insurgencies (Phillips 2011) (Moulton 2009). Three indicators, technological performance, mixed services and geography are applied for comparison of their specific capabilities.

The technological performance of a country in contrast to its enemy in both symmetrical and asymmetrical means is essential for achieving missions as well as survival. Among the various military assets, the technological performance of the major combat systems is most decisive, and those capabilities are fighters in the air, major surface combatants at sea, artillery and armour on land. The three capabilities vis-à-vis the counterparts of a potential enemy would determine the overall strategic situation, whether offensive or defensive, control or denial oriented. If a state's fighters fail to secure air superiority, the roles of other air force entities are likely to become difficult, if not impossible. By the same token, once major surface combatants are unable to establish sea control by effectively dealing with aerial surface and underwater threats, most naval operations, such as minesweeping and landing, also become unfeasible. Armies with inferior main battle tanks (MBTs) and artillery have to give up on a number of operational options, particularly offensive ones. Thus, the crucial capabilities would subsequently have an overall effect on whole forces of a state, showing the impacts of obsolescence on other capabilities. For instance, a navy with vulnerable major surface combatants would not be capable of carrying out amphibious operations during wartime, with the consequence that its outdated landing ships would become strategically irrelevant.

Regarding air superiority, the generations of fighters and assisting capabilities, such as aerial warning and command systems (AWACS) and aerial refuelling, are the key subjects for military obsolescence (Creveld 2011, 198-204). If air superiority is out of the question, SAMs and flaks can counter a hostile airpower in a relatively passive way. Therefore, a comparison between air defence and an opponent's airpower will be the focus of examination. Given a probability of securing air superiority, other aerial elements, such as ground attack and airlift, will be the main subjects for scrutiny. Since most insurgencies do not have fighters, the main challenge for counterinsurgencies (COIN) would be readiness and capacity for ground attack, airlift and surveillance, less relevant with technological performance. However, some aircraft designed specifically for COIN purposes, such as light attackers, would lower the operational costs and make the operation more sustainable (Axe 2016).

Although the generations among major surface combatants are not as clearly defined as that of fighters, their defence capabilities against aerial, surface and underwater threats would provide a useful factor regarding technological performance. Ideally, major surface combatants are supposed to have several layers of air / missile defence comprised of long-ranged (more than 100km) or short-ranged SAMs, point defence SAMs (less than 10km) and / or close-in weapon system (CIWS) in addition to electronic countermeasures (ECMs). In fact, many ships are only equipped with partial or, no capability for air / missile defence, thus making information on the different levels of such technological performance a useful reference for the survivability of ships. To deal with underwater threats from submarines requires anti-submarine warfare (ASW) capability, which is conducted with three kinds of equipment on board, ASW helicopters, variable depth sonar, and towed array sonars. Of course, other ASW supports, such as fixed winged ASW aircraft, would help to moderate threats from submarines (Ireland and Grove 1997, 214-224). It must be noted that these weapon systems would improve the gambit of naval warfare, but do not guarantee victory in real operations. The comparison between major surface combatants vis-à-vis the threats of ASCMs and torpedoes determines a state's opportunity of securing sea control. If the gambit is not optimistic, the obsolescence of capabilities attached to sea control would be less important, and the focus of obsolescence will be shifted to assets for sea denial. As for COIN, except for such extreme case as that of Hezbollah operating ASCMs, most insurgencies would lack the sophisticated capability to challenge surface vessels (Mazzetti and Shanker 2006). Therefore, technology would not matter, but capacity and readiness, especially for patrol and amphibious operations, would be important for internal or unconventional security challenges regarding naval obsolescence.

For armies, the technological performance of armour and artillery capabilities is salient for comparisons to determine the appropriate forms of land warfare. The different generations of MBTs refer to their respective levels of firepower, protection and mobility. MBT protection determines their survival in the face of not only opponent counterparts, but also anti-tank guided missiles (ATGM), a significant asymmetric countermeasure. Despite lack of

defined generations, artillery systems have significantly improved their ranges and mobility, thus making previous models inferior in engagement. Other major military assets on land, such as armoured personnel carriers (APC), IFV and reconnaissance vehicles, are not suitable for direct comparison with their adversary counterparts, because they are usually integrated with MBTs for mechanised operations. If MBTs are unable to function as armour spears, reconnaissance vehicles, APCs and IFVs are unlikely to be used for offensive purposes, but might merely provide transportation, light fire support and anti-tank missions if properly armed. Anti-tank capability is the crucial capability for defence, because significantly neutralising an enemy's armour units can stop or even repulse the enemy, evidenced in Egypt's operation in the initial stage of the Yom Kippur War (Bar-Joseph 2009). In a situation of counterinsurgency, the requirement for protection of MBT, APC, IFV and other armed vehicles would depend on the level of firepower the insurgent forces possess.

Mixed services with new and old models show a range of influence on military obsolescence in inter-state warfare. Owing to limited budgets, it is rare for a country to be able to afford constant renewal to supply all its armed forces with the latest equipment, with the result that mixed services are inevitable. This means that old assets can be used for secondary missions, such as defending flanks and training, thus leaving the newer equipment for more important operations. However, the extent of obsolescence varies according to the proportion of old to new models. The impact of mixed services is also connected to the overall balance of forces. For a state having a generally equivalent or superior military capability to its opponents, mixed services would have less of a strategic effect because there would be some surplus space for old models. In contrast, mixed services would matter more for a state in an inferior position vis-à-vis its potential enemy, because most of its forces would be mobilised during wartime and a proportion of old models could erode their defence capability.

Warfare does not occur in a vacuum, but in a real geographic environment, which also has an effect on military obsolescence. The outlines of land and sea directly set boundaries between navies and armies along with applicable operations and military structure, thus also influencing military obsolescence. For an island state, its army's obsolescence would be less serious than its navy's, because its enemy has to cross the waters first. In contrast, the obsolescence of an army would be more important than that of a navy for a continental state due to likely scenarios. Terrain determines potential means of land warfare, and consequently favours offence or defence. In a defence favourable terrain, an army with weak armour would expose its weakness less than in an offence favourable environment. Although airpower is generally free from geographic limitation, its deployment and application are inevitably attached to geographic conditions. As a result, geographic factors are indispensable for reviewing military obsolescence.

Both categories of indicators are applicable for Vietnam because of its arsenal filled with Cold War legacies and the strategic pressure from China, a potential opponent with rapid military modernisation. All indicators accommodate discussion and understanding of Vietnam's military obsolescence as well as its strategic influence. It must be noted that the analysis of Vietnam's military obsolescence is constrained by the available public sources, mainly *Military Balance* and the SIPRI Database, Thus, estimation is conducted in a relatively conservative manner.

The Case of Vietnam

Land Systems

After Moscow severed military aid, the VPA made barely any major acquisitions with the result that its arsenal resembles a "time capsule" of the Cold War. These legacies may present serious challenges to readiness and leave them technologically inferior to their Chinese counterparts.

The Vietnamese armour units, totalling up to 1270 in number, are composed of T-62, T-55/54, and type-59 MBTs introduced in the 1970s. There is recent news of a possible deal with Russian for T-90 MBTs, but as yet it has not been finalised (Sputnik 2016). Among the large number of MBTs, around 300 T-55/54s are reported to have had comprehensive upgrades in the 2010s with better firepower, engines, surveillance and protection, although no records of such upgrades exist on the SIPRI Database (Global Security 2014b) (Army Recognition 2012). The VPA armour units may have difficulty in maintaining ageing MBTs, indicated by the decrease in numbers of serviceable vehicles. For instances, 200 T-62s were introduced in 1978 and only 70 are still listed. The T-55/54s and type-59s with service throughout the Vietnam War are not clearly identified as to whether the gap between introduction and current numbers was caused by combat loss, logistical challenge or both. As there are considerable numbers of users retaining similar models of MBTs around the world, it would not be surprising for Vietnam to obtain overseas logistical support or even establish its own support facilities (IISS 2017, 150, 199-200, 368, 372). Although Beijing may not provide logistical supply for Hanoi's type-59, its similarity with the T-54 would shed light on maintenance (Foss 2002, 20-21). To this point, the VPA has the potential to keep the old MBTs operable, but this does not exclude other factors emerging to reduce their readiness.

Among the neighbouring armies, Laos and Cambodia also use similar types of MBTs in smaller numbers, but China's more advanced MBTs make the VPA tanks obsolete. T-62, T-55/54 and its Chinese replica, type-59, were designed before the Soviet Union development of modern MBTs, such as the T-64 and subsequent models from the 1960s (Koch 1999, 48-49). Despite the upgraded T-55AM3s, Vietnam's MBTs would still be seen as obsolete in terms of technological performance and the progress of a potential enemy. China has

developed and deployed several generations of MBTs, from type-85 to later models (Turner 2002, 7-8; Global Security 2014a). These Chinese MBTs are superior in firepower for the larger main guns, mobility of higher weight-power rations, and have more sophisticated armour (Table 1) (Foss 2002, 20, 70, 72, Army Guide 2015a; Military Today 2017a; Fisher 2016). ATGMs present an asymmetrical means for Hanoi to counter Beijing's superior armour forces, with recent cases proving the effectiveness of such missiles against advanced MBTs (RT News 2016). However, the VPA's anti-tank missiles are also Cold War legacies, 9M14M (AT-3) and 9M111 (AT-4), and may not penetrate the Chinese MBTs' latest protection with a single hit. Furthermore, more than three decades after production, the readiness of those Soviet ATGMs could be questionable in Vietnam's humid climate, due to ageing, especially in terms of electronic components and charges. Although there is no direct evidence to prove the lifespan of Vietnamese ATGMs, a South Korean example would be a useful reference. Seoul procured thousands of ATGMs from both the US and Russia in the 1980s and 1990s, but they had already exceeded their lifespan in 2014 (SIPRI 2017, the Chosunilbo 2014). The VPA also possesses various recoilless guns, anti-tank guns and tank destroyers, mostly vintage from World War Two, and they would be effective for attack on low-grade armoured vehicles only (IISS 2017, 338).

The VPA has a sizeable artillery force which could be classified into three groups: self-propelled guns, towed howitzers and multi-launch rockets (MLR). Vietnam's self-propelled guns are made up of a mixture of Soviet 2S1s (122mm), 2S3s (152mm) and American M-107s (175mm), and, except for the 2S3s, data regarding their introduction, upgrade and current services is incomplete. Since the 2S1s and 2S3s are still used in the Russian services, it would not be difficult for Hanoi to obtain Moscow's logistical support (IISS 2017, 33, 212, 215). The M-107, captured from South Vietnam, is a less certain prospect. Its Detroit 8V-71 diesel engines are available commercially, but factors such as the long-term US embargo, the 1980 of end production and the very few users could obstruct appropriate maintenance (Foss 2002, 486-487; IISS 2017, 167, 307, 377, 383; MTU 2017). The VPA's towed artillery systems consist of American M-101/102 105mm, Chinese type-60 (based on the Soviet D-74), Soviet M-30 and D-30 122mm, D-20 152mm and American M-114 155mm howitzers. These are all designs from the 1940s to the 1960s, and were introduced during the Vietnam War. The lack of details regarding current service numbers and losses during wartime mean that there are no indicators for readiness, but their simple structure, lacking complicated power and/or electronic components, indicates the low logistical requirements for those towed guns (IISS 2017, 339; Kindard 2007, 388, 402, 465, 471, 477-478). The VPA's MLR systems, Chinese type-63s, Soviet BM-21s and BM-14s were introduced during the Vietnam War, and their service numbers have been stable during the post-Cold War era, despite the unclear condition of the BM-14s. (IISS 2017, 339) Based on the simple tow design, the logistical challenges for the type-63 would not be high, and a number of overseas users may suggest external sources of logistics (Federation of American Scientists 1999). As BM-21s are still listed in Russia as well as in other countries, logistical support would be accessible. (IISS

2017, 212, 216) The BM-14 could be more problematic because of its old Zil-151 or 157 truck platform and a limited number of operating states (Ware 2014, 75, 181; Hull 1999, 358-359, 361-362; Gurov 2017).

The major challenge for the VPA artillery is its superior Chinese counterparts, as other neighbouring countries, Cambodia and Laos, possess similar Cold War legacies in smaller numbers. The PLA improved the ranges of its self-propelled guns and MLRs to more than 40km in the post-Cold War era, but its towed guns are neglected in the investment and most models are based on Soviet designs with ranges similar to their Vietnamese counterparts. As the PLA modernise their artillery arsenals from the indigenous industry, numbers of new guns are sufficient to achieve superiority over the VPA. In contrast, the longest range of the VPA artillery is the M-107's 32km. Although the introduction of rocket propelled projectiles can extend the range of the M-107 to 40km, its open cab without any protection is still vulnerable to artillery exchange. (Foss 2002, 434) The 2S1 and 2S3 are protected by armour, but their respectively short ranges of 15.2km and 17.3km are inferior (Hull 1999, 315, 319). Despite the Russian upgraded 2S1 being available, its maximal range of about 20km would not provide much improvement for the VPA's inferior status (Army Recognition 2016). The inferior ranges of the VPA's towed howitzers, all less than 30km, are exacerbated by their lack of mobility and protection (Table 2) (Foss 2006, 766, 911, 913; Army Guide 2015bc; Military Today 2017b; Global Security 2013; IISS 2017, 280, 338-339). Although the VPA put M-101 howitzers on Ural 375D trucks to create self-propelled guns with better mobility, the problem of short ranges is not solved (Army Recognition 2015). The VPA's MLR systems, the type-63s, BM-21s and BM-14s, are also weaker than those of Chinese counterparts due to their shorter ranges, except for the type-63 that is in service on both sides for its light weight and portability (Kindard 2007, 469-470, 477-478, 485, 488, 497).

In both small-scale armed conflicts and large-scale warfare, Vietnam's relatively outdated artillery force would put Hanoi in an unfavourable position vis-à-vis Beijing. In a Damansky / Zhenbao Island-style scenario of fire exchange, artillery units with shorter ranges would face more attack with less retaliation. If an armed conflict were to escalate to a PLA offensive, the VPA's inferior artillery would not suffice to support its weak MBTs and anti-tank firepower. Hanoi could strengthen the protection of artillery units through fortification of their positions, but those bunkers would be unable to compensate for the short ranges and could eventually be neutralised by China's airpower.

The VPA's other armoured vehicles, including light tanks, reconnaissance vehicles, APCs and IFVs are Cold War legacies as well. Since the VPA's obsolete MBTs are unlikely to run a mobile operation for offence, the opportunity of using them for offence would be limited. All the light tank models, the PT-76s, the type-63s and the type-62s, and the reconnaissance vehicles, BRDM-1 / BRDM-2, were introduced during the Vietnam War. Their mobility, if not

already considerably degenerated by time, may still carry out reconnaissance nowadays, and their service numbers have not been reduced during the post-Cold War era. However worldwide they have gradually been phased out. Except for the BRDM-2 still serving popularly in its Russian home state, the other models owned by the VPA have already been phased out in the Commonwealth of Independent States (CIS) and in Middle Eastern countries (IISS 2017, 199-233, 368-413, 429-478). In other words, maintenance on those ageing vehicles, especially the type-62 and type-63 of Chinese origin, would become difficult.

The VPA's IFVs and APCs, a large collection of various models, can be divided into two groups, those introduced during the Vietnam War and those after it. The total numbers of the VPA's APCs and IFVs have been similar since the end of the Cold War, but the two groups would have different levels of obsolescence. The IFV and APC models acquired after 1975, the BMP-1, BMP-2, BTR-60 and M-113, are relatively new and still retained in service in their states of origin, Russia and the United States (US), as well as in numerous other countries. The older APC models, including the BTR-40, BTR-50, BTR-152 and the type-63, are not only retired in their original countries, but also have shrinking numbers of users around the world. During the development of Soviet IFVs and APCs, the BTR-40 and BTR-152 were succeeded by the BTR-60, as the BMP series replaced the BTR-50s. In parallel, the type-63 was replaced by the type-85 in China. Both the BTR-40 and BTR-152 with their open roof designs are now obsolete for lack of minimum protection from air busted artillery shells (Foss 2002, 134-135, 294-295, 386-387). Therefore, the second group of APCs have a higher level of obsolescence.

Since it is unlikely for Vietnam to take an offensive stance against China, the VPA's light tanks, reconnaissance vehicles, IFVs and APCs, which constitute a land battle order, would not have an adequate stage. Mobile defence through tactical attacks is an option, but the VPA's vulnerable MBTs would imply limited opportunities only for such tactics. In other words, without improving Vietnamese MBTs, other armoured vehicles would mainly serve as transportation, light fire support and anti-tank missions.

Maritime Systems

The PAVN's obsolescence is significantly related to its strategic situation. Based on their current services in the Russian Navy and continuous production, the Project 636 submarines, Project 11661 (Gepard 3) frigates and Project 1241 fast attack craft (FAC) would be seen as state of the art and probably not technologically inferior to their Chinese counterparts (IISS 2017, 193, 213-214, 235; Frigate of 11661 project "Gepard - 3.9 n.d.). However, a salient quantitative disadvantage basically shapes the strategic situation and related missions for all VAPN capabilities. Gepard 3 frigates are equipped with two layers of

air / missile defence system, Sosna-R SAMs of 10km maximal range and AK-630 CIWS in addition to ECM capability, as well as variable depth sonars plus 533mm ASW torpedoes and RBU-6000 ASW rockets. The VPAN's new frigates would thus have certain capabilities to deal with modern threats. However, according to the current plan, the VPAN will have only six Gepards that will be far outnumbered by 31 Chinese surface combatants from the South Sea Fleet of the PLA Navy (PLAN), not to mention ASCMs from aircraft and submarines (SIPRI 2017; IISS 2017, 287, 339, 350; Nudelman Precision Engineering Design Bureau 2017; Naval Technology 2017). Apart from the Gepard 3s, Vietnam's only major surface combatants are five Project 159 corvettes, introduced in the late 1970s and early 1980s. Although they are upgraded for anti-submarine warfare (ASW), their limited displacement filled with torpedo, gun turrets, ASW rockets and mortar would signify no or marginal improvement in air / missile defence (IISS 2017, 268, 339; Russian Ships Info 2017a). The lack of sufficient capacity in dealing with approaching ASCMs would lower those ships' survivability in wartime. In other words, the VPAN's Project 159 corvettes would have limited roles upon any escalation of armed conflict because of their technological vulnerability. In sum, sea denial would be the only feasible strategic option for the VPAN.

Under the sea denial strategy, the FAC is a critical element for use in hit-and-run tactics, besides the new submarines. Besides the new Project 1241, Project 205 FACs acquired between 1979 and 1981 are unlikely to be identified as state of the art, but common arms and mixed service could moderate their obsolescence. The AK-230 CIWS and the P-15 ASCM, the main weapon systems on the Project 205 FACs, are also equipped on some Project 1241 FACs. The standard nature of the equipment and deals made between Hanoi and Moscow after the Cold War would manage the logistical challenges for retaining Project 205 FACs (SIPRI 2017; IISS 2017, 339). Furthermore, the newer and more advanced Project 1241 FACs would go some way to sharing the burden of operation to form a mixed service with old boats, which could be deployed for less challenging missions. However, it may be that the historical P-15 ASCMs with subsonic speed are easily intercepted by the PLAN, because its major surface combatants have several layers of air/missile defence. Moreover, China also received P-15s from the Soviet Union in the 1960s and its defence industry reverse engineered them to establish the foundations for the subsequent development of ASCMs (Gormley, Erickson and Yuan 2014, 9-10, 21, 27-28). Thus, the PLAN could deny VPAN's P-15 ASCMs through electronic countermeasures for its knowledge of the technical characteristics.

The VPAN's amphibious and minesweeping fleets are not covered in the naval investment, and their vessels are Cold War legacies that face an ageing challenge. The Vietnamese amphibious fleet is composed of three Soviet Project 771 medium landing ships (LSM), three American 511-class tank landing ships (LST), and other smaller landing craft (IISS 2017, 339). Their long period of time in service could result in logistical challenges, and their technological performance should be examined from a strategic perspective. During the

Cold War, the US transformed amphibious capability from two to three dimensions by adding helicopters, and some naval powers followed with similar types of platforms (Jacob 2003, 1-2). However, having large landing platforms for helicopters (LPD) or other kinds of large landing vessels suits neither affordability nor the strategic parameters of Vietnam, not to mention the issue of their vulnerability to ASCMs and torpedoes. In the face of the PLAN's anti-access and area denial (A2/AD) firepower, it is unlikely for the VPAN amphibious fleet to conduct any major operation during wartime. Therefore, Project 771, the product of the 1960s, and LST-511 of World War II vintage, are kept mainly for transportation during peace time, for which their low mobility, lack of flight deck and weak defence do not matter (NavSource 2014; Russian Ships Info 2017b).

The VPAN's minesweeping fleet is slightly larger than the amphibious counterpart, comprised of two Project 266 seagoing minesweepers, four Project 1265 coastal minesweepers, two Project 1258 inshore minesweepers and five Project T-361 (K-8) minesweeper boats, introduced from the late 1970s to late 1980s. In addition to potential logistical challenges, especially for Project 266 and T-316 which are out of service in Russia, their generally small displacement would signify their short durability at sea (IISS 2017, 214, 339). For instance, the full-loaded displacement of the seagoing Project 266, the largest type in the fleet, is only 560 ton and duration is seven days (Russian Ships Info 2017c). Furthermore, they are not equipped with modern counter-mine technology, such as unmanned mine hunting systems, meaning a relatively high risk exposure for Vietnamese vessels removing mines (Unmanned Systems Technology 2013). Hanoi's ageing and limited capacity for dealing with sea mines could present Beijing with a feasible option for blockade, which will be discussed in the section on impact.

Aerial Systems

Currently, Vietnam's third generation fighters would represent the most critical aspect of airpower, along with other assets. After the end of Soviet military aid, Hanoi has struggled with used aircraft and parts from India and Eastern European countries to support its fleets of third generation fighters, the MiG-21s and the Su-22s. Using practical means, the VPAAF managed its capacity until newer fighters, such as the Su-30, arrived (SIPRI 2017). However, in contrast to China's large-scaled modernisation of fourth generation fighters, such as the J-10, J-11B and Su-30, assisted by AWACS and aerial refuelling aircraft, in the air forces of the PLA (PLAAF) and the PLAN (PLANAF), Vietnam's third generation fighters would remain inferior for old avionics and lack of beyond-vision range (BVR) capability. Furthermore, MiG-21s and Su-22s are gradually being phased out by their users worldwide, with the result that logistical support in the future could also be problematic. Undeniably, there are also considerable numbers of third generation fighters in the Chinese air forces, but their increasing numbers of fourth generation fighters would achieve superiority over the VPAAF.

Generally, the VPAAF is quantitatively disadvantaged in both the third and the fourth-generation fighters (Table 3), making air superiority regional or partial at best for them (IISS 2017, 340).

Hanoi also applies a practical approach to modernisation for its trainer and transporter aircraft. At least 22 Yak-52 and 10 L-39 trainers were introduced from Romania and the Czech Republic in the post-Cold War era to sustain the existing fleets (SIPRI 2017). Although the manufacturers of both types of trainers have developed newer types, the Yak-52s and L-39s are still in service in their respective original countries, Russia and the Czech Republic, as well as in other countries with Soviet legacies, suggesting feasible logistical supply from external sources (A.S. Yakolev Design Bureau 2017; Aero Vodochody 2014; IISS 2017, 97, 103, 217, 340; DOSAAF Russia 2016). Furthermore, with a low probability of aerial combat, technological succession would not be serious. As for ground attack, a sub role for trainers, it would also be limited due to the uncertain air superiority and the PLA's strong air defence firepower.

Vietnam's military airlift is composed of An-26 and C-295 tactical transporters, in addition to An-2 light transporters. In the early 1980s, Moscow provided Hanoi with about 50 An-26s, but only 12 An-26s are serviceable after more than three decades. Although many An-26s are still in service in various countries, including Russia, the VPAAF did not purchase used aircraft to sustain its fleet, but has started introducing three new Spanish C-295s, an equivalent but much advanced model (Antonov 2017)(Airbus 2017). However, restricted by the small scale of procurement, the full replacement of the An-26 with the C-295 will not be achieved in the near future (IISS 2017, 215, 217, 340; SIPRI 2017). The An-2 light transporter, despite its long history and biplane design, is still useful today for its short-take-off-and-landing (STOL) capability, low speed and simple structure. Except for four imported from Poland, a considerable number of civilian users and China's continuous production would suggest little challenge for the VPAAF in accessing logistical supply (Shijiazhuang Aircraft Industry Co 2016; SIPRI 2017; IISS 2017, 340). Due to the sheer gap in airpower between Hanoi and Beijing, the opportunity to use transporters to project force during wartime would be slim, though An-2s could be used to send special forces with their low speed and low altitude, as demonstrated by North Korea (Dowling 2015).

Many of Vietnam's helicopters were Cold War legacies until a small scaled procurement in the 2000s, and certain logistical challenges are observable. During the post-Cold War era, the size of the VPAAF helicopter forces shrank from 200 to about 60, and several types, such as the Mi-6, have been phased out. The VPAN's rotary wing has suffered less, despite the withdrawal of the Ka-25 (IISS 1992, 165; IISS 2017, 340). The surviving models, the Ka-28, Mi-8, Mi-24 and UH-1H, continue to be built and operated by their original countries, Russia and the US, as well as other countries (Russian Helicopters 2017; Bell Helicopter 2017; IISS 2017, 48, 56, 215-217, 339-340). Although the US had retained its ban on arms exports to

Vietnam for decades, a number of the VPAAF's serviceable UH-1Hs suggest certain channels to logistical supply, probably not so difficult because of numerous users worldwide (Panda 2014). The Ka-28s and Mi-24s with their respective ASW and anti-tank missions would contribute to respective operations, but uncertainty around air superiority would constrain their efficiency during wartime. Although the transporter and utility helicopters, Mi-8/17 and UH-1, could deploy troops or attack ground targets, their actual function in the face of Chinese airpower and air defence firepower could be limited.

When air superiority is unachievable, the appropriate alternative for the VPAAF would be to deny Chinese airpower, and its efforts at modernisation fit this goal. From the Cold War Hanoi has arsenals and experience in operating SAMs to counter invasive air campaigns, but it is questionable as to whether those legacy missiles are obsolete. Obviously, there is no precise answer while official logistical data remains unavailable, but Vietnam's acquisitions during the post-Cold War era clearly demonstrate a plan of mixed services. The Cold War legacy SAMs are S-75s (SA-2) and S-125s (SA-3) for mid-ranges, 2K12s (SA-6) for short-ranges, and 9K32s (SA-7) for MANPADS. From the mid-1990s, Hanoi procured additional SAMs to follow these categories: S-300s for long-ranges of more than 100km, which were unavailable during the Cold War, upgraded S-125-2MTs and Israeli SPYDER-MRs for mid-ranges, and 9K310s and 9K38s for MANPADS (SIPRI 2017). The mixed services with new and old models, each having individual frequencies and other electronic characteristics, would lower the risk of total jamming and other countermeasures. However, it being several decades since production, the operational readiness of the fuels, charges, and electronic components of those old SAMs would present serious challenges. Apart from missiles, both the VPA and the VPAAF possess numerous towed and self-propelled ZSU-23 flaks (IISS 2017, 340). They may be less formidable due to their short range and low accuracy, but can still create certain obstacles for air strike. Although a considerable portion of Vietnamese air defence assets are ageing, at least Hanoi is taking certain measures to moderate the impact of obsolescence.

Although Vietnam is likely to access to logistical support for its aircraft, a certain frequency of air crashes in recent years, for both old and new models, may imply some logistical challenges, which might stem partially from ageing (VN Express 2016).

The Impacts of Obsolescence

The VPA has been more affected than the VPAN and the VPAAF by military obsolescence, where various impacts lead to respective strategic influences. The VPA's obsolete assets can be seen in two scenarios: border conflict and a small scaled invasion based on the war of 1979. Although Hanoi and Beijing have clarified land borders through treaties, a landward conflict is not impossible. As the VPA's weakness is considerable, as is the capability gap

between it and the PLA, land options could be militarily feasible for the Chinese decision makers. Two kinds of armed conflicts are probable outcomes in the event of an escalation from a border confrontation.

On the level of border conflicts, whether artillery is involved or not would determine the following situation. When engagement is restricted to light weapons, the technological gap would be smaller between the VPA and the PLA than artillery exchange, because the firepower of both sides can reach similar ranges, and the level of destruction of most defence construction would be limited. With both sides' MBTs participating in an exchange of fire, the effective ranges of their 125mm, 115mm and 100mm main guns are generally similar, and the VPA tanks could have the extra protection of defensive constructions. Therefore, the VPA's military obsolescence would not be very obvious. In contrast, the significantly different ranges of the two sides' howitzers and MRLs would see the VPA having difficulty in overcoming those of the PLA, and distinct outcomes would emerge in prolonged conflict. Hanoi has the option of introducing artillery missiles, EXTRA and R-17, to compensate for its inferior ranges, but Beijing has much larger equivalent arsenals. By the same token, applying airpower would lead to the same outcome for China's stronger air forces.

Regarding a limited war where the goal might be a city close to a border or somewhere further, there is a likelihood of mobile warfare and exposure of the VPA's weak armour capability. Although the rugged terrain would benefit the VPA's defence, it would be unavoidable for the PLA to capture some territory or even one or more targeted cities. In that case, Vietnam's old and fragile MBTs would have difficulty serving armour spears for counterattack, and relatively short ranged artillery would not successfully support the operation, especially a complete suppression of the PLA counterpart. As air superiority is uncertain, the VPAAF may not have sufficient capacity to support the VPA through ground attack or airlift force. Apart from the danger of losing territory, the geostrategic threat on Hanoi is more serious. From Liang Son to Hanoi is about 123 km, and only about half of the route is mountainous, as there is no significant strategic barrier in the Red River Delta (Distance From To 2017). The coastal corridor might provide another invasive route. Regarding the technological gaps between the PLA and VPA, Hanoi may be in danger of being captured during wartime. Obviously, to conquer Vietnam's capital would not be an easy decision because of various political costs involved for China, such as an adding to its reputation for aggression and possible international sanctions. However, this option in addition to others concerning land warfare presents Beijing with a means of exploiting the VPA's obsolescence.

The VPAN's obsolescence would be exposed in the two scenarios: sea denial and blockade by mines. Since the VPAN only has 10 Project 1241 FACs and the PLAN's threat will be multi-directions, from both north of the Tonkin Bay and the east of Hainan Island, the eight

Project 205 FACs would have important roles as well. The limited number of Vietnamese FACs would highlight the survival factor for the sustainability. In contrast to Project 1241, the weaker AK-230 CIWS and age of operational readiness would be the concerns for Project 205. Although the VPAN has other means for sea denial, malfunctioning or vulnerable Project 205 FACs would more or less erode the overall strategy. As mentioned before, the VPAN minesweeping vessels are small and lack of modern means. Therefore, the PLAN would only have to lay mines on the SLOCs connecting Vietnam's major seaports to disrupt its economy. Hanoi has no ability to undertake a similar operation to retaliate against Beijing and would have a dilemma: to sweep the sea mines or to escalate the conflict. Without significant modernisation, to sweep sea mines would be arduous, if even possible, and to escalate would also be disadvantageous for the weaker side.

As the Chinese airpower can come from both the mainland and Hainan Island, and perhaps from the newly built airbases in the South China Sea, it would be difficult for the VPAAF commanders to deploy fighters to defend against multi-directional attacks, and its less capable third generation fighters would be likely to aggravate the situation. Despite considerable numbers of third generation fighters under China's Southern Theatre Command, their numbers of fourth generation fighters would be high enough to cover most operations against Vietnam in the initial phase. Consequently, the VPAAF's third generation fighters would either fight in an inferior situation, with a likely outcome of heavy loss, or avoid engagement so that its fourth-generation fighters would be outnumbered further. If Hanoi decides to preserve its fighters and avoid engagement, its SAMs would face serious challenges, because the PLAAF and the PLANAF would not only send their fighters but also electronic warfare (EW) aircraft to suppress air defence. Whether the old S-75, S-125 and 2K12 missile systems can achieve their designed purposes under such a high intense situation is questionable.

Conclusion

The case of Vietnam also reveals difficulties for receivers of military aid. It is indeed convenient to obtain free or very cheap arms from a great power, but receiver states may not be able to establish appropriate levels of financial affordability. Although Vietnam has successfully transformed its economy and achieved high growth rates in successive years, its arsenal is still too large to comprehensively conduct proper life-cycle management of its military assets. As one-to-one replacement is beyond financial affordability for Hanoi, Vietnamese defence planners selected crucial capabilities for investment, with the remainder becoming the victim of ageing, thus presenting vulnerabilities which Beijing may exploit. Therefore, Hanoi faces a strategic dilemma in military acquisition, either to spare certain resources to modernise the VPA and other neglected capabilities, or to continue its concentration of investment on maritime and aerial capability to cater to the territorial

disputes in the East Sea (the South China Sea). It is obviously necessary to have better land defence between the capital and the Chinese border, as well as good minesweeping capability, but maritime and aerial combat forces are essential in denying China's sea power. Despite significant build-ups, the VPAN and the VPAAF are still inferior to their Chinese counterparts, but better than the VPA vis-à-vis the PLA.

The case of Vietnam demonstrates an example of the extent to which the synthetic framework for analysing military obsolescence can be applied, but further development would be necessary for applying the framework to countries in different situations, such as those with high insurgency threats and those with considerable indigenous defence industries.

Disclosure statement

No potential conflict of interest was reported by the author.

References

A.S. Yakolev Design Bureau. (2017) 'Yak-152', 27 September; accessed at http://www.yak.ru/ENG/PROD/new_152.php, 27 September 2017.

Aero Vodochody. (2014) 'L-159 Aircraft'; accessed at http://www.aero.cz/en/products-services/programs/l-159-aircraft/#scrollTo=obsah, 27 September 2017.

Airbus. (2017) 'C295', *Airbus*; accessed at https://airbusdefenceandspace.com/our-portfolio/military-aircraft/c295/, 27 September 2017.

Antonov. (2017) 'An-26'; accessed at http://www.antonov.com/aircraft/antonov-gliders-and-airplanes/an-26, 27 September 2017.

Army Guide. (2015a) 'Type 98'; accessed at http://www.army-guide.com/eng/product2387.html, 27 September 2017.

Army Guide. (2015b) 'PHZ89'; accessed at http://www.army-guide.com/eng/product4154.html, 28 September 2017.

Army Guide. (2015c) 'PLZ-52/Type 05/PLZ-05'; accessed at http://www.army-guide.com/eng/product3185.html, 28 September 2017).

Army Recognition. (2016) 'Russian Land Forces to upgrade its 122mm 2S1 Gvozdika self-propelled guns to 2S34 Hosta', 8 April; accessed at http://armyrecognition.com/april_2016_global_defense_security_news_industry/russian_land_f

orces_to_upgrade_its_122mm_2s1_gvozdika_self-propelled_guns_to_2s34_hosta_tass_30804165.html, 27 September 2017.

Army Recognition. (2015) 'Vietnam Has Developed a 105mm Self-Propelled Howitzer on a Ural-375D Chassis', 20 May; accessed at http://www.armyrecognition.com/may_2015_global_defense_security_news_uk/vietnam_has_developed_a_105mm_self-propelled_howitzer_on_a_ural-375d_chassis_20051531.html, 7 June 2017.

Army Recognition. (2012) 'Vietnamese armed forces modernize its fleet of main battle tanks T55 to the standard T54/T55M3', 25 March; accessed at http://www.armyrecognition.com/weapons_defence_industry_military_technology_uk/vietnamese_armed_forces_modernize_its_fleet_of_main_battle_tanks_t-55_to_standard_t_54/55m3_2503124.html, 13 March 2017.

Axe, David. (2016) 'American Antique Planes Battling ISIS', *MSN News,* 3 September; accessed at http://www.msn.com/en-in/news/world/america%E2%80%99s-antique-planes-battling-isis/ar-AAgyK0O, 4 July 2017.

Bar-Joseph, Uri. (2009) 'The 1973 Yom Kippur War', *Jewish Virtual Library*, May; accessed at https://www.jewishvirtuallibrary.org/jsource/isdf/text/barjoseph.pdf, 17 April 2017.

Bell Helicopter. (2017) 'Bell Huey II'; accessed at http://www.bellhelicopter.com/commercial/bell-huey-ii, 23 March 2017.

Bitzinger, Richard A. (2010) 'A New Arms Race? Explaining Recent Southeast Asian Military Acquisitions', *Contemporary Southeast Asia* 32(1): 50-69.

Buzan, Barry, and Eric Herring. (1998) *the Arms Dynamic in World Politics*, London: Boulder.

Creveld, Martin Van. (2011) *The Age of Airpower*, New York: Public Affairs.

Distance From To. (2017) September 27, 2017; accessed at http://www.distancefromto.net/distance-from-lang-son-to-hanoi-vn, 27 September 2017.

DOSAAF Russia. (2016) 'Томск: представительный мотокросс и первые полеты кадетов [Tomsk: representative Motocross and the first flyingcadets]', 14 October; accessed at http://www.dosaaf.ru/novosti/6055-tomsk-predstavitelniy-i-pervie-poleti-kadetov, 22 March 2017.

Dowling, Stephen. (2015) 'The Plane that Can fly Backwards', *BBC*, 16 April; accessed at http://www.bbc.com/future/story/20150415-the-plane-that-can-fly-backwards, 23 March 2017.

Federation of American Scientists. (1999) 'Type 63 107mm Rocket Launcher', 5 July; accessed at https://fas.org/man/dod-101/sys/land/row/type-63-r.htm, 14 April 2017.

Fisher, Richard D. Jr. (2016) 'China's Norinco develops new Type 96 MBT variant', *HIS Jane's 360*, 12 July; accessed at http://www.janes.com/article/62175/china-s-norinco-develops-new-type-96-mbt-variant, 12 April 2017.

Foss, Christopher F. (2006) *Jane's Armour and Artillery 2006-2007*, Surrey: Jane's Information Group.

Foss, Christopher F. (2002) *Jane's Tanks and Combat Vehicles Recognition Guide*, New York: Harper Collins.

Global Security. (2014a) 'Vietnamese People's Army (Ground Forces) Modernization', 17 August; accessed at http://www.globalsecurity.org/military/world/vietnam/armymodernization.htm, 13 March 2017.

Global Security. (2014b) 'Type 99A2 Main Battle Tank', 16 March; accessed at http://www.globalsecurity.org/military/world/china/type-99-a2.htm, 27 September 2017.

Global Security. (2013) 'PHL-03 300 mm long-range rocket', 5 July; accessed at http://www.globalsecurity.org/military/world/china/phl-03.htm, 26 September 2017.

Gormley, Dennis M., Andrew S. Erickson, and Jingdong Yuan. (2014) *A Low-Visibility Force Multiplier: Assessing China's Cruise Missile Ambitions*, Washington, D.C.: National Defense University Press.

Gurov, Sergei V. (2017) 'BM-14', *Military Today*; accessed at http://www.military-today.com/artillery/bm_14.htm, 27 September 2017.

Heitman, Helmoed-Römer. (2004) 'The Impact of Technology on War', in Martin Edmonds, Chyungly Lee and Greg Mills (eds), *Arms and Security in Asia*, Johannesburg: the South African Institute of International Affairs, pp. 1-21.

Horowitz, Michael C. (2010) *the Diffusion of Military Power*, Princeton: Princeton University Press.

Hull, Andrew W. (1999) *Soviet/Russian Armour and Artillery Design Practices: 1945 to Present* . Darlington, Maryland: Darlington.

International Institute for Strategic Studies. (2017) *Military Balance 2017*, London: International Institute for Strategic Studies.

International Institute for Strategic Studies. (1992) *Military Balance 1992*, London: International Institute for Strategic Studies.

International Institute for Strategic Studies. (1979) *Military Balance 1979*, London: International Institute for Strategic Studies.

Ireland, Bernard, and Eric Grove. (1997) *Jane's War At Sea 1897-1997*, London: Harper Collins.

Jacob, W. (2003) *Amphibious Operations in the 21st Century*, Carlisle Barracks, US: U.S. Army War College.

James, Andrew D. (2016) 'Emerging Technologies and Military Capability', in Richard A. Bitzinger (ed.) *Emerging Critical Technologies and Security in the Asia-Pacific 2016*, London: Palgrave Macmillan, pp. 6-21.

Kindard, Jeff. (2007) *Artillery: An Illustrated History of Its Impact*, Santa Barbara: ABC-CLIO.

Koch, Fred. (1999) *Russian Tanks and Armored Vehicles 1946-Present*, Atglen, PA: Schiffer.

Markowski, Stefan, Peter Hall, and Robert Wylie. (2010) 'Procurement and the Chain of Supply', in Stefan Markowski, Peter Hall and Robert Wylie (eds) *Defence Procurement and Industry Policy*, London: Routledge, pp. 11-44.

Mazzetti, Mark, and Thom Shanker. (2006) 'Arms Hezbollah Reveals U.S. and Israeli Blind Spot', *New York Times*, 19 July; accessed at http://www.nytimes.com/2006/07/19/world/middleeast/19missile.html, 4 July 2017.

Military Today. (2017a) 'Type 99 Main Battle Tank'; accessed at http://www.military-today.com/tanks/type_99.htm, 27 September 2017.

Military Today. (2017b) 'PLL-09 122-mm self-propelled howitzer'; accessed at http://www.military-today.com/artillery/pll_09.htm, 27 September 2017.

Moulton, John. (2009) 'Rethinking IED Strategies: from Iraq to Afghanistan', *U.S. Army*, 2 September; accessed at https://www.army.mil/article/26877/, 4 July 2017.

Naval Technology. (2017) 'Project 11661 Gepard Class Frigates, Russia'; accessed at http://www.naval-technology.com/projects/gepard-class, 27 September 2017.

Panda, Ankit. (2014) 'United States Lifts Vietnam Arms Embargo', *The Diplomat*, 3 October; accessed at http://thediplomat.com/2014/10/united-states-lifts-vietnam-arms-embargo-with-a-catch/, 23 March 2017.

PHC, Zelenodolsk Plant named after A.M. Gorky. (2017) 'Frigate of 11661 project "Gepard - 3.9"'; accessed at http://www.zdship.ru/eproducts/shipbuilding/special-purpose-vessels/460/, 27 September 2017.

Phillips, Michael M. (2011) 'Launching the Missile That Made History', *the Wall Street Journal*, 1 October; accessed at https://www.wsj.com/articles/SB10001424052970204138204576598851109446780, 4 July 2017.

RT News. (2016) "ISIS takes out Iraqi Abrams with anti-tank missile." *RT News,* 25 October; accessed at https://www.rt.com/news/363990-kornet-abrams-mosul-video/, 13 April 2017.

Russian Helicopters. (2017)"Helicopters." *Russian Helicopters*; accessed at http://www.russianhelicopters.aero/en/helicopters/, 27 September 2017.

Russian Ships Info. (2017a) 'Guard Ships Project 159'; accessed at http://russianships.info/eng/warships/project_159.htm, 27 September 2017.

Russian Ships Info. (2017b) 'Medium landing ships Project 771'; accessed at http://russianships.info/eng/warships/project_771Htm, 27 September 2017.

Russian Ships Info. (2017c) 'All Russian Minesweepers'; accessed at http://russianships.info/eng/warships/index_minesweepers.htm, 27 September 2017.

MTU. (2017) 'Series 71'; accessed at http://www.mtu-online.com/mtu/products/detroit-diesel-2-cycle/series-71/, 17 April 2017.

NavSource. (2014) 'USS LST-511', 14 March; accessed at http://www.navsource.org/archives/10/16/160511.htm, 21 March 2017.

Nudelman Precision Engineering Design Bureau. (2017) 'Sosna: Air Defense Missile System (ADMS)'; accessed at http://kbtochmash.com/press-eng/articles-eng/articles-eng_4.html, 27 September 2017.

Shijiazhuang Aircraft Industry Co. (2016) 'Shipped five B multi-purpose aircraft'; accessed at http://www.avicsaic.com/goods/Goods/info/id/17, 28 September 2017.

Stokhalm International Peace Research Institute. (2017) SIPRI Arms Transfer Database; accessed at http://www.sipri.org/databases/armstransfers/armstransfers, 27 September 2017.

Sputnik. (2016) 'Russia's T-90 Tank Interests Vietnam Because It's "More Modern" Than Rivals', *Sputnik*, 18 October; accessed at https://sputniknews.com/military/201610181046465882-vietnam-russia-t90-tank/, 13 April 2017.

Tan, Andrew T. H. (2014) *the Arms Race in Asia: Trends, Causes and Implications*, London: Routledge.

Thayer, Carlyle A. (2009) *Vietnam People's Army: Development and Modernization*, Bandar Seri Begawan: Sultan Haji Bolkiah Institute of Defence and Strategic Studies.

The Chosunilbo. (2014) 'Korea's Anti-Tank Weaponry Out of Date', 14 October; accessed at http://english.chosun.com/site/data/html_dir/2014/10/14/2014101401359.html, 12 August 2017.

Thomas, Raju G. C. (1986) *Indian Security Policy*, Princeton: Princeton University Press.

Turner, Jason. (2002) *Tracked Firepower*, St. Paul, MN: Brown Partworks.

Uberoi, J. P. S. (1989) 'Technology of Obsolescence', *Economic and Political Weekly*, 18 November, 2543.

Unmanned Systems Technology. (2013) 'U.S Navy to Introduce Unmanned Mine-hunting Surface Systems in 2017', 4 February; accessed at http://www.unmannedsystemstechnology.com/2013/02/u-s-navy-to-introduce-unmanned-mine-hunting-surface-systems-in-2017/, 21 March 2017.

VN Express. (2016) 'Military aircraft crash kills 1 in central Vietnam: official', 26 August; accessed at http://e.vnexpress.net/news/news/militaryaircraftcrashkills1incentralvietnamofficial3458663.html, 3 August 2017.

Ware, Pat. (2014) *the Illustrated Guide to Military Vehicles*, London: Hermes House.